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Edited by

J. A. MYERS, Ph.D., M.D.
Professor of Medicine
University of Minnesota
Minneapolis, Minnesota

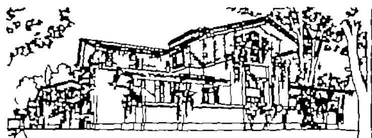
Diagnosis And Treatment Of Diseases Of The Trachea And Bronchi

By

HERMAN J MOERSCH, M.D
Section of Medicine
Mayo Clinic and Mayo Foundation
Rochester Minnesota

and

HOWARD A. ANDERSEN M.D
Section of Medicine
Mayo Clinic and Mayo Foundation
Rochester Minnesota



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DIAGNOSIS AND TREATMENT OF DISEASES OF THE TRACHEA AND BRONCHI

INTRODUCTION

The tracheobronchial tree is a structure of considerable importance for it is the pathway through which air and gases are transported to and from the lungs, a function that is essential for the maintenance of life in man. It is a dynamic rather than a static structure that elongates and expands with inspiration and shortens and contracts with expiration. The tracheobronchial tree is a tube lined by glandular epithelium that produces mucus. The mucus normally is eliminated in the expired gases and by the action of the specialized ciliated cells that line the tracheobronchial tree and sweep the secretion toward the larynx. Anything that interferes with these normal processes plays an important role in the variations of the physical findings and clinical symptoms in tracheobronchial disease.

Unfortunately a great variety of diseases and anomalies can involve the tracheobronchial tree. The clinical symptoms and physical findings produced will vary with the nature of the disease or anomaly, its location, and the degree of bronchial obstruction that it produces. It is advantageous in the diagnosis and proper treatment of tracheobronchial disease to have an accurate knowledge of the normal anatomic structure.

ANATOMIC ASPECTS

The trachea begins as a continuation of the larynx. As it enters the thorax, it deviates slightly to the right and posterior to the midline. At the level of the second costal cartilage, it bifurcates into the right and left main bronchi. The posterior membranous portion of the trachea lies in contact with the anterior wall of the esophagus. In the cervical region, the trachea is in contact with the thyroid gland which, owing to pressure, may alter the shape of the trachea. Directly in front of the trachea, and approximately at the bifurcation lies the ascending aorta. The arch of the aorta lies close to the lower portion of the left wall of the trachea. The bifurcation of the trachea lies immediately above the left auricle and behind not only the arch of the aorta but also the pulmonary artery.

The trachea divides into the two main, or stem, bronchi, which in turn divide into the secondary bronchi that run to the various lobes of the lungs. In the cleft between the trachea and the esophagus lies the symmetrically arranged chain of peritracheal lymph nodes. In the neighborhood of the bifurcation, these nodes are arranged in a thick clump and, as a result of disease, may produce pressure on the trachea and bronchus.

The segmental distribution of the bronchi to the various lobes of the lung follows a rather intricate but fairly constant pattern. Thorough knowledge of this normal anatomic arrangement is of paramount importance in the proper interpretation and understanding of tracheobronchial disease. Excellent anatomic descriptions of the bronchial segmental anatomy have been published by such authors as Boyden[1]

and Jackson and Huber The terminology describing the various segmental bronchi that was introduced by Jackson and Huber is the one most widely employed

ANOMALIES OF THE TRACHEOBRONCHIAL TREE

Congenital anomalies of the tracheobronchial tree are relatively rare It is remarkable how seldom even minor deviations from the normal bronchial pattern occur in the human being On extremely rare occasions, the ventral bud of the primitive *pharynx may fail to develop resulting in* agenesis of the lung Improper development of the ventral bud may produce lobar agenesis and may be accompanied by anomalous pulmonary venous drainage It is also possible to have aplasia of the lung with the appearance of a rudimentary bronchus but with elaboration of an alveolar parenchyma In hypoplasia, such rudimentary bronchi are *associated with meager alveolar distribution in the entire* lung or in part of it

A bronchus occasionally may arise from an abnormal position if this abnormality is not recognized, it may lead to considerable confusion and even to serious consequences if surgical procedures are attempted Such an abnormality is well illustrated in Figure 1 In this case the left main *bronchus terminated in a blind pouch approximately 2.5 cm* from the bifurcation of the trachea and the bronchus that supplied the left lung originated from the medial wall of the right main bronchus, 1 cm below the carina tracheae Similar bronchial openings at times may originate from the trachea or from the bronchi that supply aberrant lung tissue (Fig 2) It is important that such abnormal bronchi be recognized because this aberrant tissue may become involved in such diseases as tuberculosis, carcinoma and

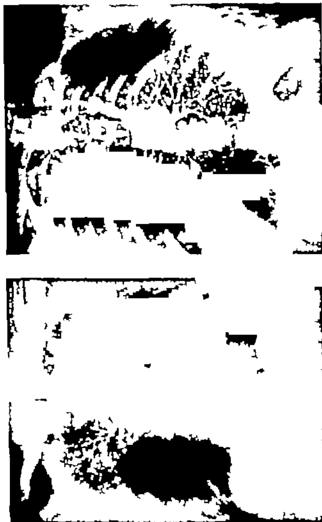


Fig 1 Abnormality in which the left main bronchus ends in blind pouch and the left main bronchus originates from the right main bronchus Fig 2 An anomalous bronchus arising from the trachea and passing to the right upper lobe

abscess if not properly localized, such involvement may offer considerable difficulty from the standpoint of treatment

An unusual anomaly is a tracheal diverticulum, which usually originates in the lower portion of the trachea on the right side The walls of the diverticulum usually have the same structure as the trachea itself and are covered with normal mucous membrane According to Chiari,[4] such an anomaly represents the incompletely developed offshoot of a third bronchus originating about the bifurcation When multiple diverticula of the trachea are present, the condition frequently has been termed trachiectasis, or more properly "tracheoectasis" On rare occasions, tracheoectasis has been associated with a tracheocele However a tracheocele may occur without tracheoectasis. Bronchial diverticula situated on the mesial wall of the stem bronchi between the bronchi to the upper and middle lobes have been described Congenital cysts arising in the wall of the trachea also are encountered occasionally

ACUTE LARYNGOTRACHEOBRONCHITIS

Acute laryngotracheobronchitis is an intense inflammation of the larynx, trachea and major bronchi commonly occurring in children. It may start with coryza as in a common cold but is soon followed by hoarseness croupy cough stridor and dyspnea When respiration is difficult, cyanosis may ensue The child frequently is severely ill and may be struggling to breathe but the degree of fever is not related to the severity of the disease The mucous membranes are red swollen and edematous, and they may obstruct mechanically the passage of air in the glottis or the subglottic region. Secretions may be thick and sticky which also plays a role in respiratory obstruction.

Bacteriologic examination of pharyngeal or tracheal secretions frequently reveals Staphylococcus pyogenes, Diplococcus pneumoniae or Haemophilus influenzae but the etiologic agent in most cases is probably a virus, with these organisms as secondary invaders. Bacteriologic studies can help differentiate this condition from diphtheria (Corynebacterium diphtheriae) and whooping cough (H pertussis) Exposure to smoke and flame nitrogen mustard gas or the smoke of white phosphorus is capable of producing a similar clinical picture

Treatment should be directed primarily toward maintenance or restoration of an adequate airway Immediate bronchoscopy followed by tracheotomy may be necessary and lifesaving Occasionally the role of the bronchoscopist is merely that of being prepared to insert the bronchoscope if total obstruction should develop while tracheotomy is being performed When the condition is less severe, it is

reasonable to defer these procedures and observe the child closely while administering cool moist air or oxygen Moisture is most effectively added by aerosolized water detergent solutions or antibiotics, such as penicillin Sometimes the addition of small doses of isopropylarterenol (isuprel hydrochloride) or epinephrine to the aerosolized solution reduces the laryngeal and tracheal edema sufficiently to improve the passage of air Parenteral use of antibiotics also is advisable

After an adequate airway has been established the prognosis is favorable Until then, however the outcome is uncertain and the prognosis is grave

VASCULAR DEFECTS

Alterations in the tracheobronchial tree may be produced by vascular abnormalities and diseases, which may be either intrinsic or extrinsic in origin.

Intrinsic vascular lesions are comparatively rare and consist mainly of hemangiomas and small aneurysms involving the small bronchial vessels. Such lesions, if of appreciable size and situated in the trachea or the main stem bronchi, can be seen readily on bronchoscopic examination and treated adequately by bronchoscopic means. Bleeding is usually the most likely symptom produced by such a lesion, although lesions of considerable size occasionally may give rise to bronchial obstruction.

Extrinsic vascular lesions are much commoner and may be divided into two main types, namely (1) those resulting from developmental anomalies, and (2) those due to organic changes involving the vascular system.

Developmental Anomalies.—Developmental lesions may be of a great many varieties. Symptoms, if present, usually occur early in life. The diagnosis of vascular anomalies that may produce clinical symptoms can be made readily in most cases from the history and the roentgenologic examination. Roentgenoscopic studies while the patient swallows barium are of tremendous value in the diagnosis of such lesion. In addition useful information often is obtained on bronchoscopic as well as esophagoscopic examination. Angiocardiography occasionally may be necessary to determine the nature of the lesion.

Right-Sided Aorta.—Among the commoner developmental anomalies that may produce tracheobronchial symp-



Fig 3 Right-sided aorta which produced deformity of esophagus and partial compression of trachea.

toms is a right sided aorta (Fig 3) Normally the aorta arises from the persistence and development of the left fourth branchial arch However should the aorta arise from the right fourth arch, the result is a right-sided vessel The right aortic arch may follow one of two courses It may arch over the right primary bronchus and descend behind the lung and to the right of the esophagus in which case it is usually designated as an anterior right sided arch or it may pass backward and then to the left and behind the esophagus, in which case it is designated a a posterior type of right-sided aortic arch In the latter type, great



Fig 4 Esophagram in case of double aortic arch

variations may occur n the branches that come off the aortic arch. The major arch alone may pass behind the esophagus or there may be in add tion, a retro-esophageal left subclavian artery that impinges on the esophagus at a higher level In some nstances, the left common carotid artery arises on the right from the proximal arch and extends across the arch and in front of the trachea, producing compression of the anterior all of the trachea and symptoms of obstruction

Persistent Double Aortic Arch — In those rare cases in which both the right and left aortic arches persist, the anomaly may g ve rise to linical symptoms As a rule, the left arch is prone to pass anterior to the trachea and is usually smaller (Fig 4) In most instances, both the trachea and the esophagus will be enclosed between the two branches

of the aorta but on rare occasions only the trachea may be enclosed Although the space between the two branches of the aortic arch sometimes is sufficient to accommodate both the trachea and the esophagus without the production of symptoms, it is much more likely that the space will not be adequate and either the trachea or the bronchus may be compressed When this occurs, stridor cyanosis and choking spells are frequent. If the esophagus is also involved, dysphagia and regurgitation often occur The symptoms usually manifest themselves early in life, and the infant has difficulty in breathing during the nursing period The degree of compression may be so great as to result in death unless the condition is recognized at an early stage and adequate surgical measures are instituted

Right Subclavian Artery — One of the commonest of the vascular anomalies that may cause tracheobronchial symptoms is a right subclavian artery that originates as the last left-sided branch from the distal part of the aortic arch. Such an anomalous right subclavian artery usually passes to its normal position by coursing from the left to the right side in front of the trachea, or between the trachea and the esophagus, or behind the esophagus, crossing the midline of the trunk at the level of the third thoracic vertebra In cases of this kind the symptoms are more likely to be esophageal than tracheal in nature, and the primary symptom frequently is transitory dysphagia which often has been termed dysphagia lusoria As a rule dysphagia lusoria is more prone to occur after the second decade of life than earlier

Organic Changes in the Vascular System —An enlarged heart may impinge on the esophagus and cause symptoms, but it is comparatively rare for such a lesion to involve the trachea Although enlargement of the heart may lead to displacement of the bronchus, it is unusual for this to produce bronchial symptoms Dilatation of the left ventricle, as in mitral stenosis, may give rise to bronchial obstruction, which always involves the left main stem bronchus.



Fig 5 Aneurysm of the aorta invading the left main bronchus

A much commoner cause of tracheobronchial difficulty is impingement on the trachea and bronchus by an aortic aneurysm (Fig 5) An aneurysm of the aorta not only may press on the bronchus, producing bronchial obstruction, but it may invade the wall of the bronchus and protrude into the bronchial lumen, causing obstruction and a clinical picture closely simulating that of tumor of the bronchus. The development of an aortic aneurysm with impingement on the trachea or bronchus may be extremely slow or comparatively rapid The degree of bronchial obstruction may be pronounced

Bleeding is rather common in cases of aortic aneurysm in which the lumen of the trachea or bronchus is invaded The bleeding may be intermittent, although it is much more prone to be massive and fatal.

In addition to involvement of the bronchus or trachea an aortic aneurysm may impinge on the esophagus and

produce esophageal obstruction or invade the esophagus, with perforation into the esophagus itself

The diagnosis of aortic aneurysm may offer some difficulty especially if the aneurysm occurs in a younger person and is not associated with positive results of serologic tests for syphilis. In cases of this type roentgenologic examination of the thorax may be confusing because the findings are compatible with those seen in bronchial tumor Bronchoscopy may be of great value in the diagnosis, but care must be exercised in the removal of tissue from such a lesion for microscopic diagnosis because it may cause fatal massive bleeding When the presence of an aortic aneurysm is suspected *it is extremely important that the patient have* the benefit of a thorough clinical and fluoroscopic examination before any tissue is removed for microscopic study

TUMORS OF THE TRACHEA

Tracheal tumors are comparatively rare Because of the dramatic symptoms that tumors of the trachea may produce they are always of special interest. They may result from a great variety of causes but for purposes of discussion they are best divided into two categories, namely malignant and benign. Of 82 proved tracheal tumors studied at the Mayo Clinic 47 were malignant and 35 were benign (see table)

Malignant Tumors.—Although no portion of the trachea is immune to carcinoma it occurs more frequently in the lower half than in the upper portion It arises more frequently from the lateral and posterior wall of the trachea but occasionally may completely encircle the lumen It occurs more frequently in men than n women, in a ratio of approximately 4 1 Although it may occur at any period of life it is most often seen in the later decades of life, like carcinoma lsewhere n th body

Malignant tumors of the tra hea may atta n considerable size before giving rise to symptoms, or the symptoms, if present, may be of such indefinite character that they may be easily disregarded Dyspnea, stridor cough and, less often hemoptysis and hoarseness are the symptoms most frequently encountered The patient symptoms sometimes are misinterpreted as being due to asthma, and this well exemplifies the old aphorism of Jackson that "all that wheezes is not asthma

Although the diagnosis of a tracheal tumor often can be suspected or established by roentgenograms of the thorax or by tomography t is dependent in most ases on bronchoscopic examination The bronchoscopic appearance of the lesion

is variable depending largely on the type of the malignant tumor. As in primary carcinoma of the bronchus, the exact diagnosis is dependent on the microscopic appearance of cells found in the secretion or of tissue removed from the tumor.

Squamous cell carcinoma is by far the commonest carcinoma of the trachea. Adenocarcinomas are encountered less frequently and it is possible that these all originate primarily in a main stem bronchus and extend into and involve the lower end of the trachea.

Adenoma of the trachea occurs with a frequency almost equal to that of squamous cell carcinoma. Morphologically the adenomas in our series were all of the cylindroma type. They may show evidence of peritracheal extension and may invade contiguous structures. Widespread metastasis is rare.

Benign Tumors.—Benign tumors of the tracheobronchial tree are comparatively rare. They may produce the same symptoms that occur with malignant lesions involving the trachea. As seen in the afore mentioned table, a variety of benign tumors may originate in the trachea.

Papilloma.—This is by far the commonest benign tracheal tumor. It originates from the surface epithelium and may be single or multiple. When present in children such tumors cause more respiratory difficulty than they do in adults because of the greater relative impingement on the tracheal or bronchial lumen.

Tracheopathia Osteoplastica.—This is one of the most interesting of the benign tumors of the trachea (Fig. 6). It appears under the mucosa, between the cartilaginous rings, as a nodule composed of cartilage and bone. In most cases the nodules are multiple, may involve the entire length of the trachea and may extend down into the bronchi. It is most likely to occur in the fifth and sixth decades of life. Such tumors may produce symptoms that are dependent on their size, number and distribution. The condition may be recognized from roentgenologic examination, especially tomographic studies.



Fig 6 Calcified deposits in trachea in case of tracheopathia osteoplastica Inset shows bronchoscopic appearance of the bony nodules in the trachea

Amyloid tumor xanthoma and chondroma occur with great rarity All five such tumors listed in the table gave rise to symptoms.

Treatment.—The treatment of tracheal tumors depends largely on the type of lesion present. The past 5 years have seen great advances in the surgical removal of a segment or portion of the wall of the trachea With this improvement in surgical technic, tumors that formerly had to be treated palliatively now can be removed in their entirety with a good chance of cure

Carcinoma of the trachea if the tumor has not infiltrated into contiguous structures or metastasized elsewhere, can be removed surgically the continuity of the trachea being maintained by direct anastomosis or the use of a plastic or

metal tube to replace the severed trachea The local excision of tumors such as cylindroma, with reconstruction of the tracheal wall, is being accomplished with increasing frequency If the tumor cannot be removed by excision, a great deal often can be accomplished by destruction of the tumor by electrocoagulation done directly through the bronchoscope or by means of tracheotomy The implantation of radon, the use of roentgen therapy and exposure to the cobalt bomb have a definite place in the treatment of malignant lesions of the trachea.

CHRONIC BRONCHITIS

Chronic bronchitis is a term frequently used as a "waste basket" when a cause for chronic cough is not evident. The condition actually exists, however and is exceedingly common. It consists of inflammation of the bronchial mucous membrane that is usually secondary to infections, such as the common cold, measles, whooping cough and influenza, or to inhaled irritants, such as cigaret smoke, farm or industrial dusts and chemical fumes. Other conditions, such as bronchial asthma, may have an associated bronchitis with cough; conversely chronic bronchitis with cough may be followed by bronchospasm or wheezing, commonly called asthmatic bronchitis. Bronchiectasis, lung abscess or any suppurative process in the lungs may be associated with irritative bronchitis in those bronchi bathed with purulent secretion. Purulent bronchitis may exist without permanent changes in the bronchi such as occur in bronchiectasis. Bronchitis with cough may result from nocturnal aspiration of the contents of a pharyngo-esophageal diverticulum or of material regurgitated from the esophagus in cardiospasm. Esophageal hiatal hernia with an associated incompetence of the cardia may allow gastric contents to be regurgitated and aspirated nocturnally. Aspiration of contents of the nasal passageways, such as oily nose drops or purulent material draining from infected paranasal sinuses, may cause the same type of irritative reaction on bronchial mucosa. Finally the mechanical irritation of the act of coughing is in itself capable of perpetuating bronchitis.

Diagnosis.—Cough and expectoration are the chief symptoms. Cough may be merely an occasional solitary expulsive

effort or may be so severe that the patient has frequent prolonged paroxysms associated with laryngospasm. These episodes may be terribly frightening to the uninitiated. Anxiety with its associated hyperventilation may ensue and thus may precipitate similar and more alarming paroxysms. A "habit cough," or one not caused by any demonstrable disease, is frequently a deep rasping cough that may occur in severe paroxysms.

Secretion may be absent, scant or profuse. Mucoid sputum is described as clear, stringy or bubbly, and it may range from colorless ("white") to yellow. Purulent sputum is thick or creamy and may be gray, gray-green or yellow-green. The physician should inspect a specimen of sputum, if at all possible, rather than depend on the patient's description.

The diagnosis of chronic bronchitis should be made only after other diseases such as tumors, tuberculosis, fungous diseases, foreign bodies in the bronchus, congestive cardiac failure, emphysema or any other disease capable of causing a cough have been excluded. The evaluation should include adequate historical information and physical examination. A roentgenogram of the thorax should be made to exclude other diseases as much as possible, and bronchoscopy often is necessary. When purulent sputum is present, bilateral bronchograms may be essential to exclude the possibility of bronchiectasis. Bacteriologic investigation of sputum is advisable not only to aid in excluding such conditions as tuberculosis and fungous diseases but because it may be of help in outlining treatment. The diagnosis of chronic bronchitis is hazardous without a thorough examination.

Treatment.—The treatment of chronic bronchitis depends on elimination of the underlying cause. By all odds the commonest bronchial irritant is inhaled cigaret smoke. Thus, any person with chronic bronchitis has a good chance of being helped by stopping the use of cigarets. One should eliminate other inciting irritants, however, whether these be inhaled, infectious or mechanical elements.

Chronic bronchitis frequently is perpetuated by the act of coughing itself as already mentioned. Many patients believe they should do their best to cough up even tiny amounts of secretion and will make strenuous expulsive efforts to do so. Calm reassurance by the physician that nothing is seriously wrong and teaching patients the fallacy of this habit frequently suffice. The act of coughing may be compared to the rubbing of sandpaper up and down the inflamed air passages. Rest and freedom from irritation are required for the healing of most tissues, and thus pronounced "overcough" should be eliminated. Little tricks for the suppression of cough, such as the cessation of breathing when the "tickle" or other stimulus for coughing is first noted, may be helpful. The patient should concentrate on the suppression of cough rather than on an attempt to raise a small amount of mucoid secretion that is not an irritant.

Antitussive agents are chiefly narcotic drugs and should be avoided except for short term use. Codeine, dihydrocodeinone, methadone and dihydromorphinone hydrochloride (dilaudid) are the agents used most frequently. They usually are combined in a syrup with expectorants, such as potassium iodide or ammonium chloride, and may be helpful for temporary use in order to provide rest for the bronchial mucous membrane. Nonnarcotic agents such as carbetapentane citrate (toclase), caramiphen ethanedisulfonate (toryn) and dextromethorphan hydrobromide (romilar) are newer antitussive drugs. Thus far it has been difficult to evaluate their efficacy clinically. A person with nocturnal cough may benefit from sedation at bedtime in order to obtain two or three consecutive nights of rest and break his cycle or "habit" of coughing.

Expectorants are agents that are supposed to increase the volume and decrease the viscosity of sputum, making it resemble normal mucus, which is easily excreted by ciliary and normal bronchial action. These agents include potassium iodide, sodium iodide, ammonium chloride, antimony (as in

BRONCHIECTASIS

Bronchiectasis is an inflammatory disease of the bronchopulmonary tree characterized by dilatation and partial destruction of the bronchial wall. In addition, parenchymal changes usually occur in the pulmonary segments served by these bronchi. The disease is becoming less common and it is generally conceded that this decreased incidence is largely due to the availability of antibiotics for treatment of pulmonary infections.

Etiology.—Although Laennec first described bronchiectasis almost 150 years ago, the pathogenesis in all cases is not known with certainty.

Bronchial obstruction and its resultant inflammatory process in the bronchial walls and pulmonary tissues are factors common to most cases of bronchiectasis. This obstruction is obvious when bronchiectasis is associated with inhaled foreign bodies, endobronchial tumors, cicatricial bronchial stenosis or bronchial compression from lymph nodes. Bronchial glands continue to secrete mucus that cannot be expelled, and the bronchus dilates. Whether this dilatation becomes permanent depends on the amount of damage to the bronchial wall, which depends in turn on the duration of obstruction and the amount of inflammatory reaction in the bronchus and surrounding parenchymal tissue.

Bacterial and viral pneumonias are common antecedents of bronchiectasis. The factor of bronchial obstruction, even though not so obvious, is still present in association with parenchymal inflammatory disease. The mucosa of inflamed bronchi may swell sufficiently to block the passageways.

Plugs of mucopurulent secretion may obstruct small or large bronchi, which then become dilated This dilatation may revert to normal (pseudobronchiectasis) or may progress to permanent bronchiectasis. The onset of the disease fre quently can be traced to attacks of measles or pertussis or to the severe influenza epidemi of 1918 and 1919 in this country

Aspirational pneumonia may result in bronchiectasis and presents the combination of bronchial obstruction and infec tion Tonsillectomy dental extra tions or other operations n the nose mouth or pharynx are fraught with the danger of aspirational pneumonitis or abscess. The same may be said for any abdominal operation with manipulation of organs of the upper intestinal tract regurgitation and aspiration of gastric contents commonly occur Esophageal disorders such as achalasia (cardiospasm) and pharyngoesophageal diverticulum are associated with nocturnal regur gitation and aspiration of contents of the esophagus or pouch, causing pneumonitis and bronchiectasis Users of oily nasal drops or those who take mineral oil just before going to bed are candidates for development of l poid pneumonitis and bronchiectasis.

Sinusitis is frequently found in association with bronchiectasis, but t is probably a complication rather than a causal factor Most patients with this association have noted symptoms of bronchiectasis before those of sinusitis. How ever the exact relationship is not completely clear

Kartagener s syndrome is a triad of bronchiectasis, sinusitis and situs inversus Originally described by Kartagener others have concluded that bronchiectasis occurs in 15 to 20 per cent of all patients w th dextrocardia

Cystic fibrosis of the pancreas frequently is accompanied by bronchiectasis. The secretions are thick, sticky and viscid, and the term mucoviscidosis" has been applied to the disease It is a diffuse process nvolving all lobes and may progress to generalized obstructi e empl ysema Respiratory

symptoms and recurrent episodes of pneumonia are often the most predominant features.

Agammaglobulinemia is a disturbance of the immunologic response of a person usually resulting in a chronic or recurrent suppurative process. Bronchiectasis has been demonstrated in approximately 20 per cent of the reported cases.

Healed tuberculosis, lung abscess and other pulmonary suppurative processes may cause residual bronchiectasis.

Pathology.—The fundamental changes in bronchiectasis are those of inflammatory destruction of peripheral bronchi, which are not only dilated but lengthened and thickened. Variable amounts of parenchymal involvement of the lung occur from chronic interstitial and alveolar pneumonitis, which may result in fibrosis and contraction of that portion of the lung.

The bronchial mucosa may show ulceration or metaplasia with loss of cilia and a tendency to squamatization. The submucosa is infiltrated by inflammatory cells and a variable amount of fibrosis. The mucosal glands may decrease in number. The musculature, elastic tissue and cartilage of the bronchial wall are destroyed to varying degrees. Changes in the blood vessels are frequent and consist of endarteritis. Enlarged inflammatory lymph nodes may surround major bronchi serving bronchiectatic lungs.

Clinical Features.—Cough with production of purulent sputum is the predominant symptom. The amount of sputum varies greatly from none at all, such as in "dry bronchiectasis," to a cup or more daily. Its purulent character is described variously as thick and yellow, yellow-green, gray-green or green. It may be malodorous. One glimpse of the sputum is much more valuable than a description. If sputum is not readily expectorated, the physician should not hesitate to obtain some by the use of postural drainage of the bronchi. This is most easily performed by having the patient kneel on a chair or davenport, placing the hands on the floor and staying in this position for a minute or so.

Children and women sometimes have difficulty expectorating sputum for examination because of their habit of swallowing anything coughed

Prolonged cough and sputum after a common cold are frequent in patients who have bronchiectasis. Some state they have no cough except for one that persists 1 or 2 months after an ordinary upper respiratory infection

Frequent episodes of pneumonia and pleuritic pain should make one suspicious of the presence of bronchiectasis, especially if epeated roentgenograms show the pneumonitis in the same location or if pleuritic pain is al vays on the same side.

Hemoptysis is common and varies from slight streaking in sputum to a pinkish, homogeneously colored specimen to frank hemoptysis of a cup or more of blood Fatal hemor rhage is rare. Hemoptysis frequently s produced by over exertion and often is associated with acute infection of the respiratory tract It is typical of upper lobe bronchiectasis and "dry bronchiectasis" of the other lobes to have recurrent hemoptysis as the only symptom.

Dyspnea and cyanosis in association with bronchiectasis may mean extensive disease or may be indicative of the development of emphysema late in the course of the disease They are ominous manifestations. Lassitud fatigability malaise, anorexia and loss of weight are manifestations seen n almost any chronic infection Metastatic abscesses in other portions of the body such as the brain are uncommon since antibiotics have become available

Pulmonary osteoarthropathy is ind cative of long-standing disease when associated with bronchiectasis Its exact cause is unknown but it is most commonly manifested by clubbing of the fingers and toes. Tenderness may be present along some of the long bones, such as the tibia as the result of periosteal proliferation

Roentgenographi Featu es.—Several features n stereoscopic posteroanterior views of the thorax are suggestive of

bronchiectasis These signs are not pathognomonic of the disease however the more of them that are present, the more certain one can be of the diagnosis.

Increased pulmonary markings are the most common of these features They consist of linear shadows extending from the hilus in a direction corresponding to the distribution of the bronchial tree They may be due to fibrotic changes in the bronchial wall and surrounding tissue, or they may reflect the collection of purulent secretion in the bronchus. They are the least dependable of the roentgenologic signs because they are found in other conditions, such as congestive cardiac failure, and because it is extremely difficult to make the distinction between normal and slightly increased markings

Chronic pneumonitis is found less frequently and usually is associated with the other features. Honeycombing or ring shadows may be seen in any type of pulmonary fibrosis with secondary emphysematous air sacs but sometimes occur in bronchiectasis

Contraction of a portion of the lung such as an atelectatic or collapsed lobe, is sometimes due to bronchiectasis. When the right middle lobe is involved a hazy triangular shadow extends laterally from just below the hilus (Fig 7a) On the lateral roentgenogram, a dense linear shadow extends diagonally anteriorly and downward from the hilus (Fig 7b) When either lower lobe is collapsed a dense triangular shadow is seen in the cardiophrenic angle. On the left, this is usually superimposed on the cardiac silhouette (Fig 8) on the right, the cardiac border merely may appear to be straightened The lateral view may be normal or may show only diffuse haziness in the region of the lower lobe.

Bronchoscopic and Bronchographic Features.—The diagnosis of bronchiectasis is made with a reasonable degree of certainty by bronchography However before an opaque medium is instilled into the tracheobronchial tree, it is wise to do a bronchoscopic examination chiefly in order to



Fig. 7 a and b Two roentgenographic views, showing contracted right middle lobe.



Fig 8 Roentgenographic appearance of contracted left lower lobe

exclude an obstructing lesion One frequently can determine the side from which most of the purulent secretion is coming Furthermore if bronchoscopy is done just prior to bronchography secretion may be aspirated to allow better filling by the opaque medium

Bronchograms are best performed with the patient under topical anesthesia, but in children it is usually necessary to use general anesthesia After adequate anesthetization of the pharynx, larynx, trachea and major bronchi, a catheter may be introduced into the bronchi and the opaque medium may be instilled with or without fluoroscopic guidance by

positioning the patient so that each bronchus is filled. Omission of use of the fluoroscope is simpler for both patient and physician, and proper positioning of the patient provides adequate filling of each segment.

The type of opaque medium used has varied. Powdered bismuth oxide was used as early as 1905, but it was not until 1922 that an iodized oil was used. For the next 25 or 30 years, the iodized oils, such as lipiodol (poppy-seed oil), iodochlorol (peanut oil) and lipoiodine (sesame-seed oil) were the most commonly used media. Their chief disadvantage is their slow disappearance from the lung. These oils occasionally have produced lipoid pneumonitis or granulomas in the lung.

Water-soluble media were introduced in 1948 and have the advantage of rapid roentgenologic disappearance. Within 2 hours, one cannot tell roentgenologically whether an opaque medium has been given. These water-soluble media include a table organic iodide, namely iodopyracet (diodrast) in sodium carboxymethylcellulose, such as xumbradil viscous B (Astra) and ioduron B (Cilag).

More recently propyliodone (dionosil) has been introduced in both aqueous and oily forms. It has the advantage of rapid roentgenologic disappearance (2 to 4 days) and the oily form is less irritating to the bronchi than is the water soluble form. At present, this medium has gained wide acceptance. Barium sulfate and chelated compounds of heavy metals have been proposed as bronchographic media, but these compounds need further study at present.

Reactions of sensitivity occur occasionally with the use of any of these substances. Iodism, manifested by malaise, slight fever, tender swelling of the salivary glands simulating mumps, and lacrimation, may appear within 4 to 6 hours. It usually disappears within 3 days. A shocklike reaction is most likely to occur in patients with known allergies. It appears within 20 to 40 minutes and sometimes is associated with a convulsive seizure. Epinephrine should be given



Fig 9 Normal bronchogram. a. Right side. b. Left side.



Fig 10 Bronchographic appearance in bronchiectasis of the saccular type.

immediately and a mi ture of oxygen and hel um should be administered by mask

Technically satisfactory bronchograms should show filling of each segmental bronchus, including the upper lobes. A tandard system of nomenclature of bronchopulmonary seg ments is desirable nd that suggested by Jackson and Huber is the most videly accepted Al veolar filling with opaque medium is undesirable but should not be too disturbing because t almost al vays means that the bronchi serving these alveoli are normal even though they may not be well seen. Ideally however a normal bronchogram should resemble a tree without leaves ("winter tree pattern) rather than the 'summer-tree pattern of alveolar filling (Fig 9)

Bronchiectasis may be demonstrated in a cylindric cystic or saccular form (Fig 10) It is most common in th lower lobes but may occur in any segment In disease of the lower

lobes, the superior segment is usually spared but the middle lobe on the right or the lingular segment on the left frequently may be involved. The anterior segment of the right upper lobe is also commonly affected. The right middle lobe may be the only portion of the lung affected and may be associated with the middle lobe syndrome.

Studies of Pulmonary Function.—At present, physiologic studies of the lung appear to play a minor role in appraising a person with bronchiectasis. The tests are not of diagnostic value but may be of help in evaluating the patient as a surgical risk. In this regard, however, the exercise tolerance of the patient, the depth and vigor of respiration, the forcefulness of the cough and the diaphragmatic excursion as determined by percussion are just as helpful. As a general rule, if the patient can perform a normal day's activity, studies of pulmonary function may not be useful except as a base line for postoperative comparison. Bronchospirometry with evaluation of each lung separately provides the most helpful data, especially if one is contemplating bilateral surgical procedures.

Surgical Treatment.—Permanent bronchiectasis can be eradicated only by surgical removal of the diseased portions of the lung. This treatment should be given serious consideration in every adult who has unilateral disease and in many who have bilateral disease. The mortality rate in properly selected and prepared patients operated on by experienced surgeons is only 1 or 2 per cent.

Indications for surgical treatment depend on the degree of symptoms, age of the patient, extent of disease, and the desires of the patient. When the disease is asymptomatic or when a localized zone of bronchiectasis is discovered in searching for the cause of slight hemoptysis, one should be reluctant to advise such a major operation. When pulmonary suppuration or hemoptysis is moderate to severe or when recurrent pneumonitis and pleurisy are problems, surgical intervention should be considered. In patients less

than 5 or more than 50 years of age, the operation should be entertained only under exceptional circumstances. Those whose tolerance for exercise is limited usually have such extensive disease that surgical treatment is inadvisable. The maximal amount of pulmonary tissue that should be considered for surgical removal is one entire lung or segments of two lungs totaling not more than those in one lung. Some patients have had the right lower and middle lobes, the left lower lobe and the lingular segment of the left upper lobe removed, but other factors, such as age and general condition, must be ideal in such patients or pulmonary function will be dangerously compromised. Sometimes, in bilateral disease resection of the affected tissue on the side in which the greater amount of disease is located provides so much benefit that further resection either is inadvisable or is refused by the patient.

Preoperative preparation by postural drainage and administration of antibiotics is desirable to eliminate purulent bronchial secretions as much as possible at the time of operation. When lipiodol or iodochlorol is used for bronchography, it is probably best to defer surgical treatment for 4 to 6 weeks or until evacuation of the medium is fairly complete. With the water-soluble media or oily dionosil, however, such a delay does not appear to be necessary. Tracheotomy done either preoperatively or immediately postoperatively while the patient is still under anesthesia, may be desirable when bronchial secretion is copious or when cough is weak.

The surgeon should remove the involved segments or lobes by careful dissection and individual ligation. The advisability of retaining the superior segment of the lower lobe rather than resecting it with the diseased basal segment when it is not involved by bronchiectasis, is debatable; recent evidence indicates that postoperative complications might be increased by such retention but that long term results justify an attempt to save this segment.

Medical Treatment.—When surgical excision is not advisable palliative medical treatment should be given. The principal aim of this is to minimize the suppurative process or secondary infection as much as possible.

Good food adequate rest, sufficient humidification of the home and avoidance of bronchial irritants such as tobacco smoke are helpful Upper respiratory infections are deleterious to bronchiectatic patients and sometimes a change to a warm dry climate decreases the incidence of these However dust commonly encountered in such a location may be enough of an irritant to produce an increase in bronchorrhea and a permanent change of residence should not be considered without a temporary trial Sinusitis may require separate treatment, but as a rule it is helped by controlling bronchiectasis with medications or by eliminating pulmonary suppuration by surgical intervention. Treatment of associated bronchial asthma may be necessary although frequently bronchiectasis is the trigger mechanism

Thinning of thick viscid bronchial secretions may be desirable and can be done in various ways. An adequate intake of fluid is essential and may be supplemented by the use of iodides or ammonium chloride Inhalation of steam or aerosolized solutions such as sterile water sometimes used as a diluent for antibiotics, wetting agents such as triton A 20 or proteolytic enzymes such as trypsin or streptokinase may loosen sticky secretions.

Postural drainage should be designed to evacuate properly the parts of the lung affected Inasmuch as the lower lobes or the dependent portions of the lungs are involved most commonly the act of lying across a bed with elbows on the floor or kneeling on a davenport and placing the hands on the floor should allow secretion to be expelled by gravity This should be done three or four times daily for 10 or 15 minutes at the beginning of treatment. Later the patient may become discouraged because he does not produce much sputum and is likely to stop Rather he should decrease and

increase the frequency of postural drainage in accordance with the amount of material available for expectoration.

Antibiotics combined with intermittent postural drainage are valuable aids in the treatment of bronchiectasis. Opinions vary concerning the amount and type of antibiotics to be used, but all observers agree that their use has changed considerably the outlook of a bronchiectatic patient. In order to choose the prope medicament, it is best to know what organisms are present in the sputum. This is especially true if antibiotics have been given previously, thereby altering the flora. Once the predominant organisms are obtained by culture, their sensitivity to various antibiotics an be determined n vitro and the proper medicament can be administered. However t must be admitted that dramatic response to the "proper" antibiotic is not always obtained in actual treatment of a patient and one is sometimes forced to try others.

Penicillin and broad-spectrum antibiotics such as tetracycline are the agents employed most commonly at present. Penicillin may be used orally parenterally or by aerosolization. Tetracycline usually is given orally. The amount necessary varies with each patient, but in general it is best to start with a large dose such as 1 000 000 to 2,000 000 units of penicillin or 2 gm. of tetracycline given daily in divided doses. Administration should be continued until the amount of sputum is greatly decreased and this period is usually not more than a week if effective postural drainage is used also. The length of the period may depend of course, on the extent of disease the amount of suppuration and the sensitivity of the organisms.

Other antibiotics, such as treptomycin or dihydrostreptomycin and erythromycin, may be ndicated depending on the bacterial flora, but these antimicrobial agents play a less important role.

The frequency with which administration of antibiotics is recommended varies among physicians. Some state that

these agents should be saved for serious infections so that they will still be effective when needed. Others use moderately large doses for long periods, feeling that much disability is prevented. Still others consider that certain medicaments such as the broad-spectrum antibiotics suppress the usual flora, allowing the emergence of organisms such as Pseudomonas aeruginosa or Bacillus proteus that have serious potentialities and that are more difficult to eradicate.

It is our opinion that antibiotics such as penicillin and tetracycline should be administered to patients who have bronchiectasis with each upper respiratory infection or common cold and that it is safe to use such agents intermittently for 4 or 5 days at a time to control copious suppuration, which is annoying to the patient and his associates. The frequency of these periods of administration will vary from person to person, and it is safe to let most of these patients regulate the interval between treatments if they are conscientious enough to use postural drainage diligently and wisely.

Prognosis and Prevention.—Prior to the advent of surgical treatment and antibiotics, patients who had bronchiectasis lived shortened and unhappy lives. Pneumonia, *empyema, brain abscess and amyloidosis* frequently were fatal complications. At present, many patients with bronchiectasis survive, with the subsequent development of pulmonary emphysema.

When surgical excision is possible, however, one can expect 75 per cent of the patients to return to full vocational activity with few or no remaining symptoms. Surgical intervention commonly is recommended for bronchiectasis in children, but a recent study showed that the results are not so good as they are in adult life. New lesions of bronchiectasis or zones of residual bronchiectasis are likely to be found after operation in a higher proportion of children than adults, probably because of postoperative complications, such as retention of secretions.

Bronchiectasis may be prevented by early removal of bronchial obstruction due to foreign bodies and by adequate prevention and treatment of pulmonary infections. Pertussis can be prevented by inoculation, and measles frequently can be attenuated. Pneumonia and tuberculosis usually can be treated with effective chemotherapy and antibiotics.

FOREIGN BODIES IN THE TRACHEOBRONCHIAL TREE

The aspiration of a foreign body into the tracheobronchial tree usually is accompanied by such dramatic sequelae that the diagnosis in most cases is made with ease and bronchoscopic removal of the foreign body is advised Unfortunately instances still remain in which prompt removal of the foreign body is not advised, there being a tendency to procrastinate in the hope that the foreign body will be coughed out. The chance of such a termination is extremely remote The seriousness of permitting a foreign body to remain in the lung is well realized when it is pointed out that the mortality rate is more than 50 per cent if such a course is followed In contrast, the mortality rate attendant on bronchoscopic removal of foreign bodies from the tracheobronchial tree in the hands of a skilled bronchoscopist is less than 1 per cent.

A more difficult problem is the recognition of the overlooked or forgotten aspirated foreign body It is surprising how frequently a patient may forget the incident during which he aspirated a foreign body The possibility of the presence of an aspirated foreign body must be kept in mind constantly in every instance of pulmonary suppuration and in cases in which unexplained wheeze is present (Fig 11) Unfortunately a typical diagnostic picture for all instances of aspirated foreign body does not exist. The sequence of events that usually follows aspiration of a foreign body varies with the character size and shape of the foreign body and the age of the patient The initial act of aspirating a foreign body into the tracheobronchial tree generally is associated with a violent paroxysm of coughing and, less frequently

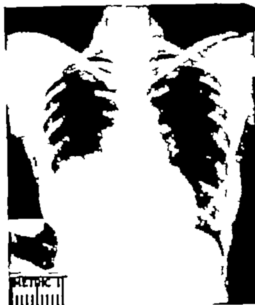


Fig 11 Pulmonary suppuration due to an aspirated foreign body (bone) The patient did not recall aspirating the foreign body Inset, the foreign body

wheezing Unless the foreign body is of such size as to produce interference with respiration, a period generally follows in which the patient is free of pulmonary symptoms. This asymptomatic period varies in duration and may last *for several hours or even for years, dependent again on the* character and size of the foreign body It is during this period that the foreign body is most likely to be overlooked The late symptoms of an aspirated foreign body are usually those of pulmonary suppurative disease, namely cough, expectoration, hemoptysis and occasionally wheeze

Vegetable foreign matter is more likely to cause severe and acute pulmonary damage than are metallic foreign bodies. Vegetable foreign bodies produce severe bronchitis,



Fig 12. Roentgenographic appearance in case in which foreign body had been present in bronchus for 17 years.

which is characterized by rapid accumulation of thick, purulent secretion and pronounced hyperemia swelling and edema of the bronchial mucosa The bronchi distal to the point of the foreign body tend to fill with purulent exudate

A nonobstructive foreign body may remain dormant in a bronchus for months or even years without producing any appreciable degree of pathologic change in the bronchial tube (Fig 12) This delay in effect is frequent when straight pins have been aspirated into the bronchi Corrosion and mechanical irritation eventually lead to the development of obstruction of the bronchus and concomitant secondary pulmonary suppuration. If a foreign body especially of

metallic material is allowed to remain in the bronchus for a long period, a stricture generally will develop at the site where the foreign body has lodged. With time, the bronchus below the site of the stricture tends to dilate and the foreign body may drop into this dilated bronchus. This is technically important in removal of an aspirated foreign body from the bronchial tree because when it takes place dilation of the stricture is necessary before the foreign body can be safely withdrawn from the bronchus

The physical findings on examination of the thorax in cases of aspirated tracheobronchial foreign body vary with the size, character and location of the foreign body and with the degree and character of bronchial obstruction produced In addition, secondary suppurative changes may greatly alter the physical findings In the interpretation of physical findings in cases of foreign body in the tracheobronchial tree, it must be recalled that the bronchi are not static tubes but constantly change in size and length during respiration As a result, constant variations exist in the ease with which air can pass through the bronchus and about the foreign body during respiration

The bronchial obstruction resulting from aspirated foreign bodies has been described by Jackson and Jackson as of four types, a classification that is of special value in the interpretation of physical findings.

Type I Partial Bronchial Obstruction. — This type of obstruction is manifested by interference with free passage of air through the bronchus in which the foreign body is lodged and interference with normal drainage of the bronchus distal to the point of obstruction As a consequence limitation of expansion of the lung on the involved side is present On percussion, slight impairment in resonance may be noted over the thorax in the region below the point of bronchial obstruction. Auscultation may reveal harsh blowing respiratory sounds with passage of air about the foreign body The respiratory sounds are diminished over the region of

increased dullness, vocal and tactile fremitus may be impaired, and rales are often present

Type 2 Expiratory Check Valve Obstruction — Interference with free egress of air during expiration is the characteristic of this type of obstruction This is especially likely to occur in the presence of round foreign bodies of vegetable matter With expiration the bronchus narrows, closing about the foreign body and thus interfering with the expulsion of air As a result, the lung in which the obstruction exists becomes overdistended with air and shows great limitation of expansion Percussion over the involved lung reveals tympanitic sounds Respiratory sounds are diminished or absent Rales are not heard on the invaded side, although they may be present on the free side Vocal resonance and fremitus are altered but little

Type 3 Complete Bronchial Obstruction — This type is characterized by interference with entrance of air into the lung beyond the point of obstruction The air that was in the lung distal to the obstruction is soon absorbed, and secretions rapidly accumulate on the side of involvement, producing the typical picture of atelectasis. As a result, limitation of expansion great impairment of the percussion note, and an absence of respiratory sounds and of rales are noted in the involved lung The heart usually shifts toward the side of involvement, and the diaphragm is elevated on this side Compensatory emphysema is present on the free side.

Type 4 Inspiratory Check Valve Obstruction. — This form of obstruction is the reverse of type 2 and probably immediately precedes type 3 It is of extremely short duration and little practical significance.

Roentgenographic Studies. — Roentgenographic examination of the lungs should be done in all cases in which aspiration of a foreign body is suspected In addition to the routine anteroposterior and lateral thoracic roentgenograms, it is recommended that roentgenograms be made at the end of both inspiration and expiration.



Fig 13. An aspirated foreign body which produced expiratory check valve type of obstruction

The roentgenographic findings vary with the type of foreign body and the degree and character of bronchial obstruction Opaque foreign bodies are recognized readily greater difficulty will be experienced with nonopaque foreign bodies. Roentgenographic examination of the thorax in bronchial obstruction of type 1 does not reveal characteristic findings In cases of type 2, the expiratory heck-valve obstruction, t is especially important that the roentgenogram be made at the end of exp ration, a otherwise the true tate of affairs may be missed This condition is characterized by greater transparency of th lung on the obstructed side displacement of the heart to the uninvolved side and depression and flattening of the dome of the diaphragm with limitation of diaphragmatic excursion on the side of obstruction (Fig 13) In cases of type 3 the atelectatic form of obstruction increased density is present over the region from which aeration nd drainage to the lung have been cut off (Fig 14) Depending on the degree of atelectasis, the heart may be shifted to the invol ed side, with homolateral levation of the diaphragm

When secondary suppurative changes take place in the

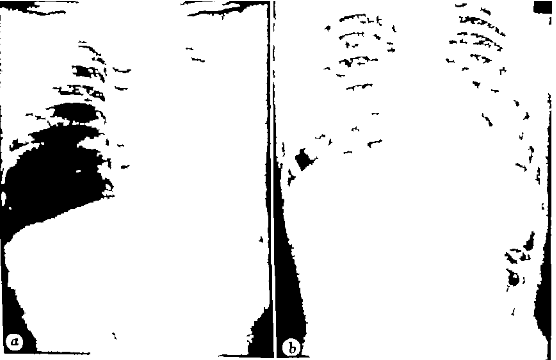


Fig 14 a. Collapse of left lung caused by inhalation of piece of woolen blanket. b Appearance in same case 12 hours after removal of foreign body from left mai bronchus

lung as a result of an aspirated foreign body they may over shadow completely the roentgenographic findings just described Although none of the secondary roentgenographic changes are diagnostic of the presence of a foreign body they should be interpreted as strongly indicating that special search should be made to rule out the possibility of an underlying foreign body It must be emphasized that a normal roentgenogram of the thorax does not eliminate the existence of a foreign body in the tracheobronchial tree

The presence of a foreign body in the trachea or bronchus always should be looked on as an emergency and the foreign body should be removed as soon as possible However it is seldom that its presence indicates such a serious emergency that bronchoscopic examination should be done without the advantage of full and careful clinical study under the best possible circumstances. The practice of inverting the patient in an attempt to dislodge the foreign body from the tracheobronchial tree is to be condemned as unsafe as the change of position may dislodge the foreign body so that it may become wedged in the glottis, resulting in spasm and complete asphyxia of the patient Although safe removal of a foreign body at the first bronchoscopy can be accomplished in practically all cases, a second or third bronchoscopy occasionally may be required

A characteristic of an aspirated foreign body in the tracheobronchial tree is that in most cases, even after the foreign body has been in the lung for a considerable length of time and has set up extensive pathologic processes, the difficulty will clear up promptly on removal of the foreign body

TUBERCULOSIS OF THE TRACHEOBRONCHIAL TREE

Tuberculosis of the trachea and bronchi has been recognized for many years. According to Smart,[23] Richard Morton, in 1694 was probably the first to describe lesions of the bronchi due to tuberculosis Since then numerous reports, based primarily on necropsy studies, have appeared It has been only in the past 2 or 3 decades, with the more widespread use of the bronchoscope as a diagnostic aid in the study of pulmonary disease, that the true clinical significance of the disease has been appreciated The advent of thoracic surgery and the introduction of antituberculotic drugs in the treatment of pulmonary tuberculosis have added immeasurably to knowledge concerning its development, cause and complications

A difference of opinion exists among observers as to the incidence of tuberculous tracheobronchitis. It has been stated that it occurs in from 10 to 60 per cent of all cases of pulmonary tuberculosis. This discrepancy as to incidence is chiefly dependent on whether the observations are based on bronchoscopic appearance alone or on the study of operative or necropsy material To a lesser extent, the discrepancy depends on the state of advancement of the pulmonary tuberculosis in the particular group of cases reported *Although tuberculous tracheobronchitis is more likely to be* present in advanced pulmonary tuberculosis than in early disease, it may occur at any stage.

The manner in which the trachea and bronchi become involved in the tuberculous process has not been definitely established they are seldom the primary site of the disease.

Experience indicates that tuberculosis of the trachea and bronchi may develop through a number of routes. In the first place, tuberculosis may spread to the bronchi and trachea by way of the lymphatic system into the mucous glands. The lymphatic structures surrounding the major bronchi, the trachea and the mediastinum absorb infected material from the periphery of the lung. As a result of the close contact of the mucous glands with diseased lymphatic tissues, the glands are attacked and thus carry infected material through the walls of the bronchi into the mucous membrane. Secondly the disease may extend directly to the bronchus or trachea from neighboring tuberculous tissue. Thirdly direct implantation may occur from infected sputum or secretions such as accompany the discharge from a tuberculous focus into a bronchus.

Pathologic Aspects.—The bronchoscopic appearance of the lesions of tuberculous tracheobronchitis varies with the particular form taken by the disease and its stage of development. In children, the earliest bronchoscopic findings are usually those produced by enlargement of mediastinal, tracheal and bronchial lymph nodes, which impinge on the tracheobronchial tree and cause fixation and narrowing of the airway. In contrast, the earliest findings in adults consist of reddening and edema of the mucous membrane; these changes may be diffuse but more often are localized to a small region situated about or opposite the opening of the bronchus. The reddened mucosa soon assumes a granular appearance due to the multiple small discrete tubercles in the submucosa (Fig. 15). Such an infiltrative process may undergo resolution and leave little evidence of its previous existence or it may go on to the hyperplastic or ulcerative form.

The hyperplastic form is characterized by thickening of the bronchial mucous membrane associated with submucosal lymphocytic infiltration. The mucous membrane is less flexible with a decrease in the diameter of the bronchial or



Fig 15 Tuberculous ulcer of trachea and bronchi.

tracheal lumen The submucosal tubercles tend to conglomerate. This may go on to the formation of a tuberculoma that protrudes into the lumen of the bronchus and presents the appearance of a benign tumor (Fig 16)

In the ulcerative form, small pin point zones of ulceration appear It is difficult at first to distinguish these small ulcers from flecks of mucus. The small ulcers tend to coalesce and fuse, forming larger zones of ulceration that vary in size, perhaps involving the entire circumference of the trachea or bronchus. The edge of the ulcerated region is generally ragged and the base is covered with a dirty grayish exudate. Granulation tissue, which generally is regarded as indicative of ulceration, is frequently present and projects into the lumen of the trachea or bronchus, presenting the appearance of a tumor and sometimes completely obliterating the zone of ulceration. The tendency of the ulcerative hyperplastic process is to heal, and this may lead to fibrostenosis.

The fibrostenotic stage is characterized by narrowing of the lumen of a bronchus or the trachea. The stenotic zone is firm and the lumen may be reduced to a pin-point opening The mucous membrane overlying the stricture may be



Fig 16. Tuberculoma of trachea.

smooth or may exhibit several areas of ulceration or granulation Th stenosis occurs usually as the result of healing of tuberculous ulceration less frequently it results from localized submucosal infiltration. Purulent material usually exudes from the stenotic opening When the cause of the stricture is not clear it advisabl to aspirate secretion from below the stricture for exam nation for acid-fast organisms and fungi, since proof of the cause of the lesion often can be thus obtained (Fig 17)

Tuberculosis of the hilar and tracheal lymph nodes may lead to hanges in the trachea and bronchi that may produce



Fig 17 Atelectasis due to tuberculous stricture

clinical symptoms. This is especially common in infants and young children Continued pressure on the bronchus or trachea is accompanied by an inflammatory reaction in the mucous membrane overlying the tuberculotic node. The mucous membrane which at first appears congested, gradually becomes paler in color and thinned out At this stage, determination of the cause underlying the process may be impossible Although the lesion may retrogress at this stage without perforation of the tracheal or bronchial wall the node or its contents more frequently may rupture into the lumen of the tracheobronchial tree and be evacuated (Fig 18) If the patient is examined at this stage the opening through the wall of the trachea or bronchus can be seen readily Study of tissue or secretions obtained from the opening may lead to the correct diagnosis. An anthracotic node



Fig 18. Deformity of lower end of trachea due to tuberculous node

may produce a similar picture. As a rule after the node or its contents have been evacuated into a bronchus or the trachea the entire process may subside or a small pitting scar may be left at the site of the perforation. However, should evacuation take place into the esophagus at the same time, an esophagotracheal or esophagobronchial fistula may be formed.

Signs and Symptoms. — Although tuberculous tracheobronchitis may produce a definite train of clinical symptoms, these symptoms are not necessarily characteristic of tuberculous but may be produced by carcinoma, benign tumors, foreign bodies or other lesions.

Partial stenosis of the tracheobronchial tree causes a wheezing stridulous type of respiration that is especially noticeable with exertion or speech and when the patient is recumbent The patient may have attacks of asthma and increased dyspnea with exertion. Dependent on the degree of bronchial obstruction, variations may occur in the amount of sputum Fever may be present when there is interference with drainage of secretions with evacuation of the retained secretions, the fever subsides promptly Ormerod[17] stated that pain which generally is aggravated by coughing is frequently present behind the sternum in ulcerative tuberculosis of the trachea and bronchi Bleeding may occur Warren and associates[24] found evidence of tuberculous bronchial ulceration or stenosis in 57 per cent of the cases of pulmonary tuberculosis in which the afore-mentioned train of symptoms was present.

The physical findings in tuberculous tracheobronchitis also depend on the degree of mechanical obstruction present in the tracheobronchial tree. Atelectasis of one or more lobes may result from obstruction caused by stricture or tuberculoma (Fig 19) The presence of atelectasis, especially atelectasis that fluctuates in degree, should strongly suggest tuberculous tracheobronchitis of the ball valve type

McIndoe and co-workers[13] stated that the roentgenologic findings of importance in suggesting tuberculous tracheobronchitis include (1) the presence of atelectasis, especially if fluctuating (2) a tendency to unexpected and unexplained spread of the disease, and (3) evidence of a partially obstructed cavity with a fluid level While these findings are not pathognomonic of tuberculous tracheobronchitis, they are strong presumptive evidence in the face of active pulmonary tuberculosis Of all these, atelectasis is by far the most significant.

Indications and Contraindications for Bronchoscopy — It has become a routine procedure in many sanatoriums to perform bronchoscopy on all patients at the time of their



Fig. 19 Atelectasis of the right middle lobe caused by tuberculosis. a Posteroanterior view. b Lateral view.

admission except when some contraindication is present. On the other hand such authors as Samson[1] have stated that this procedure is not indicated unless the patients present *symptoms indicative of tuberculous tracheobronchitis*, for in their experience such lesions seldom will be found in the absence of a characteristic syndrome The problem is not so simple or clear-cut however when the physician's experience is not limited to the care of patients with tuberculosis.

Bronchoscopy should be employed (1) in any case of pulmonary tuberculosis associated with wheeze, stridor evidence of atelectasis, obstructive emphysema or variations in sputum with associated symptoms that might suggest *bronchial obstruction*, (2) in any case in which a question exists as to the accuracy of the diagnosis of tuberculosis, (3) *in any case in which the patient continues to have sputum* containing tubercle bacilli in spite of the fact that the pulmonary lesion apparently has been controlled by artificial pneumothorax or thoracoplasty (4) in event of spread of the disease to a healthy lung when such a complication is not expected on the basis of the existing pulmonary condition, and (5) as a routine procedure in all cases of pulmonary tuberculosis in which resection of the lung or thoracoplasty is undertaken It has been amply demonstrated that the operative results will be far superior if an intact mucous membrane exists than if such is not the case, even though the bronchial wall itself may continue to harbor tuberculous disease in spite of mucosal healing

Comparatively few contraindications to bronchoscopy are present in pulmonary tuberculosis If the procedure is done with caution it rarely aggravates the disease. Bronchoscopy should not be done (1) in the presence of acute laryngeal tuberculosis, (2) on a patient with pulmonary tuberculosis who has had recent extensive pulmonary hemorrhage or (3) on a patient who has far advanced tuberculosis and who has toxemia and cachexia

Treatment. — The introduction of antituberculotic drugs in the treatment of pulmonary tuberculosis has changed completely the former concept of treatment of this disease. In most instances, a tuberculous process involving the trachea and bronchus will respond to such drug therapy with fairly rapid epithelial healing. The maximal benefit in bronchial and tracheal lesion to be obtained by chemotherapy usually are evident within 6 to 1 months. When surgical treatment is to be undertaken n pulmonary tuberculous, it is well to adhere strictly to the rule that the most satisfactory results are obtained with a quiescent bronchus.

In those instances in which a fibrostenotic lesion has been brought under control much progress has been made in dealing with such a lesion by means of plastic surgical procedures on the trachea or bronchus, along with resection. When obstruction is caused by pressure from a tuberculous lymph node a satisfactory response to drug therapy also may be anticipated. Only on rare occasions will surgical measures be required.

BRONCHOGENIC CARCINOMA

Bronchogenic carcinoma accounts for more than 10 per cent of all carcinomas in the human body Like carcinoma elsewhere in the body it is prone to occur primarily in persons who are more than 40 years of age. It occurs about eight times as frequently in men as in women.

Symptoms. — Unfortunately carcinoma of the lung is often so insidious in its onset and so rapid in its development that its earliest manifestations may be produced by extension of the tumor or by metastasis. The symptoms depend in large measure on the location of the tumor its size, the degree of bronchial obstruction and the presence of secondary infection beyond the site of bronchial obstruction Tumors that arise in the periphery of the lung and are small seldom produce symptoms. However the majority of lesions originate in the larger bronchi and tend to cause symptoms

Cough is usually the earliest and commonest symptom in carcinoma of the lung being present in 85 per cent of patients. It is often extremely difficult to evaluate this symptom because such a large percentage of the patients smoke cigarets and cough is such a prevalent finding in smokers. The onset of cough or a change in the character of cough in a middle aged person always should cause concern. At first, when the tumor is small, the cough is usually dry and nonproductive as the tumor increases in size, producing interference in drainage of the bronchus and secondary infection beyond the point of obstruction, the cough becomes productive of mucoid or mucopurulent secretion

Ulceration invariably occurs with an enlarging carcinomatous process and often causes bleeding which is present

n at least 50 per cent of patients who have carcinoma of the lung. The bleeding generally is not profuse often producing only streaking of the sputum.

Although loss of weight seldom is referred to as of diagnostic significance in carcinoma of the lung it is common in this disease. More than two thirds of patients who have carcinoma of the lung show evidence of such loss. Weakness often goes hand in hand with this finding.

Approximately one half of patients who have carcinoma of the lung complain of some discomfort or fullness n the thorax. The longer the tumor has been present the more likely is this symptom to occur. Severe pa n is not common but when present is usually indicative of direct extension of the growth into the thoracic wall, pleura or mediastinum. Constant dull pain in the back causes one to suspect the presence of mediastinal invasion or extension into the spinal column. Pa n extend ng down either arm usually indicates involvement of intercostal nerves or the brachial plexus.

Dyspnea is ommon n bronchogenic carcinoma but usually appears late n the course of the disease. Its severity largely depends on the site of the tumor the degree of bronchial obstruction and the extent of secondary suppuration. When pleural effusion occurs, th degree of dyspnea invariably increases. Wheezing respiration is noted by th patient or detected at the time of examination in approximately 10 per cent of cases. It is more likely to occur lat n the disease although in rare instances it may be the initial symptom.

Hoarseness is not common n carcinoma of the lung but when present is indicative of spread of the tumor to the med astinum, w th impingement on the recurrent laryngeal nerve. The possibil ty of carcinoma of the lung must be ruled out in any case of unexplained hoarseness.

Symptoms of Secondary Infection — W th increase in size of the bronchial growth and interference with normal drainage nfection of the bronchial tree beyond the growth

invariably takes place This infection may be nothing more than bronchitis or it may develop into bronchiectasis, pneumonitis, pulmonary abscess, pulmonary gangrene or empyema Such infections, because of improper drainage, frequently cause recurrent bouts of chills and fever that may last from 3 to 5 days. Any so-called pneumonia that does not clear up promptly should be looked on with great suspicion, and every effort should be made to exclude the possibility of an underlying carcinoma "Flu from which recovery is extremely slow in a patient past middle age should be regarded with suspicion Unexplained pulmonary abscesses or empyema should be placed in the same category

Clinical Findings. — The physical findings in primary carcinoma of the bronchus depend on the situation of the tumor its size, the degree of bronchial obstruction, the presence of secondary inflammatory changes and the amount of pleural involvement. A small lesion in the periphery of the lung or in a large bronchus may escape detection even with the most careful examination and may be discovered only accidentally during the course of bronchoscopy or more likely on roentgenologic examination (Fig 20)

An all too frequent tendency exists to neglect physical examination of the thorax or to disregard completely its results in evaluating the problem of bronchogenic carcinoma Although it is true that results of physical examination of the thorax often are inconclusive or show nothing abnormal, the procedure never should be omitted It is only by paying meticulous care to all diagnostic aids that progress can be made in prompt and early recognition of these lesions. This examination also may add information that influences the physician in selecting the most suitable treatment

A most valuable but frequently neglected aid in physical diagnosis is inspection of the thorax with the patient recumbent Often such inspection discloses that one side of the thorax lags behind its mate on inspiration, which should cause one to suspect the presence of an intrapulmonary



Fig 2(Circumscribed lesion of bronchogenic arcinoma ith shadow superimposed on the anterior end of the lef second il

lesion on the affected side Spec al attent on hould be directed to the presence of wheeze Th an be licited best by having the recumbent patient breathe with the mouth open If th tumor or the egion of pulmonary t lectasis produced by the tumor is lose to the thoracic wall dullness on percussion may be found over th nvolved portion The most mportant find ng on uscultation is suppression of br tl sounds over the eg on of im ol ment When secondary infect on l a developed nd bronchial obstruction not ompl t scattered coarse ales may be sociated w tl suppression of breath sound Fluid in the pleur l a ity ompletely obscures th foregoing find ngs nd only dullness or fl tnes on per ussion w th suppression or bsenc of bre th sound may be noted

Clubbing of the fingers n patient mor than 40 years of age especially when of recent onset and noted n connection w tl thor cic dise se of short duration should cause

one to suspect the presence of pulmonary carcinoma, after the possibility of empyema has been excluded

A careful search for metastatic lesions in lymph nodes is obligatory in every case of suspected pulmonary carcinoma. The supraclavicular regions and the axillae must be palpated carefully for enlarged and firm lymph nodes. An undiagnosed pulmonary lesion that has been present for months often can be diagnosed correctly by the simple procedure of identifying a hard lymph node in the supraclavicular region or axilla. This finding often alters the problem of treatment.

When a tumor arises in the apex of the lung which is the so-called superior sulcus tumor (Pancoast's tumor) Horner's syndrome may be present on the homolateral side some atrophy of the muscles of the hand and arm may be present on the same side These findings result from invasion of the tumor from the apex of the lung into the supraclavicular fossa and mediastinum, with involvement of the sympathetic chain and the brachial plexus (Fig 21)

Roentgenologic Features.—Roentgenologic examination of the thorax is of great value in the diagnosis of carcinoma of the lung Unfortunately the classic signs of bronchogenic carcinoma usually are produced by changes present late in the disease. From the diagnostic standpoint, it is useful to consider the development of bronchial carcinoma as occurring in either a peripheral small bronchus or a central large portion of the bronchial tree The signs of disease may be those of the actual mass itself or those produced by the effects of the mass, *namely those of bronchial obstruc* peripheral mass growing primarily extraluminally a fairly

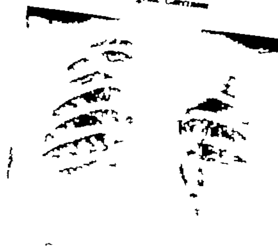


Fig 1 Superior sulcus tumor (Pancoast umor) pex of lef lung

of bronchoscopy they may be located by the skillful use of body-section roentgenography or by bron hography The former method may reveal unrecognized bronchial occlusion, unsuspected ca itation or enlargement of paratra heal and hilar lymph nodes it may aid n the differentiation between a solid tumor and a collapsed segment of lung Bronchography may reveal either ntrabronchial or extrabronchial lesions, but t is seldom helpful in the diagnosis of bronchogenic arc noma

Ther a e no card nal roentgenologic signs of arcinoma of the bronchus because the features change with continuing growth of the lesion However when a large bronchopulmonary segment becomes obstructed, one may detect diminution n olume of the portion of lung affected together with increased radiodensity result ng from loss of air and accumulation of secret ons (Fig 22 and 3) If major bronchi are involved there may be elevation of the dia



Fig 22 Primary carcinoma of bronchus producing localized atelectasis



Fig 23 Carcinoma of the lung with pronounced roentgenographic changes



Fig. 24 Late stage of central bronchogenic carcinoma Not poorly defined border

phragm, narrowing of the intercostal paces, spread ng of the shadows of the uninvol ed ascular and bronchial structures on the ffected side and a shift of the mediastinum to that side

In the later tages of developm t of en ral tumors, the growt characteristics of the particula tumor and the associated inflammatory hanges ha e great effect on the roentgenologic f tures Thus, tumor spreading periph erally *through lymphatic channel* ma present a poorly defined peripheral border or reticulated appearance (F g 24) Large hila masses bordered by clear lung or bilateral paramediastin l masses are more likely to be caused by mediast nal tumors than by bronchial inomas, althoug



Fig 25 Cavitating squamous cell
Note fluid level a. Anter



Fig 26 Cavitating carcinoma of the lung

the former may produce bronchial obstruction by extrinsic pressure

It is not always possible to differentiate cavitating carcinoma of the lung and a pulmonary abscess (Fig 25) Actually the former may be considered as a special example of the latter A thick wall with an irregular poorly defined interior surface and relatively well-defined external outline has been considered to favor the diagnosis of a cavitating neoplasm (Fig 26) However a cavitating neoplasm at times also may present roentgenologic evidence of a classic benign pulmonary abscess, with a relatively smooth interior outline and a less well-demarcated external contour that may fade imperceptibly into the poorly defined shadow of an inflammatory process.

Pathologic Aspects.—It has been recognized for a long time that bronchogenic carcinoma varies greatly in its clinical manifestations and its operability and resectability. The factor that appears to be most responsible for these characteristics is the cellular type of the tumor itself.

Bronchogenic carcinoma may be divided into various groups depending on the type of cells involved. McDonald and associates classified bronchogenic carcinoma into four groups, namely (1) small cell carcinoma, (2) adenocarcinoma, (3) squamous cell carcinoma and (4) large cell carcinoma. Some bronchogenic carcinomas are not made up of a single cellular type but have a mixed histopathologic pattern. Parts of the same tumor may be made up of different cellular types.

In a study of 767 proved bronchogenic carcinoma seen at the Mayo Clinic 38 per cent were of the large cell type, 34 per cent of the squamous cell variety and 16 per cent of the small cell type; the remaining 12 per cent were adenocarcinomas. Squamous cell carcinoma occurred 27 times more frequently in men than in women, and small cell carcinoma was 29 times as frequent in men as it was in women. In contrast, adenocarcinoma and large cell carcinoma occurred respectively four and six times more frequently in men than in women.

The various types of tumor also differ in their predilection as to the site of origin in the lung. Small cell and squamous cell carcinomas tend to originate primarily in the large stem bronchi. Adenocarcinoma tends to originate more frequently in peripheral bronchi, whereas large cell carcinoma occurs about equally in the peripheral and in the central portions of the lung. As might be anticipated, the type of tumor is of significance in the ease of diagnosis.

Cytology of Sputum and Bronchial Secretion.—One of the most important and valuable aids in the diagnosis of carcinoma of the lung has been the development of a satisfactory method for the cytologic study of sputum and bron-

chial secretions for malignant cells. Woolner and McDonald were able to make a positive diagnosis of carcinoma of the lung from cytologic study of sputum and bronchial secretions in 68 per cent of routine cases of carcinoma of the lung. A positive cytologic diagnosis of carcinoma of the lung can be made much more readily in cases in which the tumor originates from a large stem bronchus than in those in which it arises from a peripheral bronchus. In small cell carcinoma and squamous cell carcinoma in which the tumor originates primarily in the large stem bronchi, a positive cytologic diagnosis can be made in 93 per cent of cases. Conversely, in adenocarcinoma, which arises primarily in the peripheral bronchi, a cytologic diagnosis can be made in only 48 per cent of cases.

Bronchoscopy.—Bronchoscopy is of value in the study of carcinoma of the lung from the standpoint of diagnosis and also because it may assist in exact location of the tumor. Although carcinoma of the bronchus usually presents a characteristic appearance as seen through the bronchoscope, difficulty may be experienced at times in differentiating this lesion from adenomas, tuberculomas or inflammatory lesions. Consequently, removal of tissue from the lesion for microscopic examination is imperative. Negative results of bronchoscopic examination by no means rule out the possibility of a pulmonary tumor. While the great majority of bronchogenic carcinomas arise from the large stem bronchi and should be visible readily during bronchoscopic examination, some lesions are located in smaller stem bronchi that cannot be seen bronchoscopically or reached by means of biopsy forceps. The percentage of bronchogenic carcinomas that can be seen bronchoscopically and from which tissue can be removed for microscopic diagnosis depends on the type of lesion being examined. It is possible to make a positive bronchoscopic diagnosis in more than 80 per cent of cases of small cell carcinoma of the lung. In contrast, a positive bronchoscopic diagnosis can be made in only about 28 per

cent of adenocarcinomas, which arise from the peripheral bronchi

Biopsy of Lymph Nodes.—The removal and microscopic examination of suspiciously firm lymph nodes from the supraclavicular region in patients who have indefinite pulmonary lesions always should be considered. Suspicious lymph nodes in the axilla or over the thoracic wall should be considered as suitable material for biopsy in unexplained pulmonary lesions Occasionally when all routine diagnostic measures have failed and palpable supraclavicular lymph nodes are absent, a lymph node containing malignant cells can be found in the anterior mediastinal space or in the retrosternal fat pad

Thoracentesis and needle biopsy of the lung are other procedures that may be of value in the diagnosis of carcinoma of the lung

In spite of all the diagnostic procedures available a sizable group of cases remains in which the only method of establishing the diagnosis is exploratory thoracotomy

Treatment.—The treatment of carcinoma of the lung is primarily surgical Early and complete surgical eradication, as in carcinoma elsewhere in the body is the procedure of choice The results to be anticipated from surgical interference depend largely on the cellular type of the carcinoma The most satisfactory results from surgical resection are obtained in adenocarcinoma and the squamous cell variety Approximately 50 per cent of patients with squamous cell carcinoma and 58 per cent of patients with adenocarcinoma are suitable candidates for exploratory thoracotomy resection can be accomplished in 60 to 70 per cent of these patients. Following resection, 40 per cent of patients who had squamous cell carcinoma and 54 per cent of those who had adenocarcinoma will be living and well 5 years after operation. The results of surgical treatment of small cell and large cell carcinoma are much less favorable and in small cell car

cinoma especially it is imperative that some other form of therapy be seriously considered.

High-voltage roentgen therapy or use of radioactive cobalt (Co^{60}) may be considered in cases in which the carcinoma is not resectable or it may be given postoperatively when only palliative resection is done. Treatment of this form must be considered to be palliative.

Chemotherapeutic agents have been disappointing to the present time, but this form of treatment appears to hold the most promise for the future. Nitrogen mustard given intravenously has provided temporary benefit for many patients with nonresectable bronchogenic carcinomas. This is particularly true of the small cell variety. No claim for lengthening life can be made but regression of symptoms and transient decrease in size of the lesions have been noted.

ALVEOLAR CELL TUMOR OF THE LUNG

Alveolar cell tumor of the lung is a distinct entity that is frequently confused with bronchogenic carcinoma. The literature abounds with speculation as to its relationship to jagziekte in sheep. The facts available at present do not allow a complete resolution of these problems. It is a comparatively rare tumor being encountered in only 1 or 2 per cent of all bronchogenic malignant tumors. It occurs slightly more frequently in men than in women (3.2). While it may occur at any age, it is much more frequently seen in the sixth decade of life. The tumor may involve varying segments of the lung. It may occur as a circumscribed nodule or involve a complete lobe; on occasion, the entire lung may be affected. Microscopically the alveolar septa are lined by nonciliated columnar cells. Some cells contain mucus and pools of mucus may be present in the alveolar spaces. Papillary projections into the alveolar spaces may be seen in some zones.

Symptoms. — Cough is usually the earliest and most common symptom. In most cases, the cough is productive of a thin mucoid type of secretion that varies greatly in amount but is usually copious. Hemoptysis may occur but is most likely a late manifestation of the disease. Dyspnea is common, occurring in about half the patients; it is invariably constant and progressive once it develops. Fever, chills and loss of weight are other symptoms occasionally noted.

The physical signs are dependent on the extent of the underlying pathologic condition but are of little value in attaining an accurate diagnosis.



Fig 27 Alveolar cell tumor of lung

Roentgenologic Features.—Although oentgenologic examination of the thorax ha demonstrated a lesion in every case we have encountered, there is nothing entirely chara teristic about the roentgenologic findings (Fig 27) A poorly defined zone of consolidation laving the appearance of ground glass usually is seen this may be localized to one part of the lung or associated spotty zones of infiltration may be present in other portions of the same lung or in the contralateral lung Pleural fluid is present n bout 10 per cent of cases.

Bronchoscopy nd Cyt logic Examination. — Bronchoscopy is of l ttl direct value in the diagnosis of al eolar cell tumor of tl e lung In only one of 11 ases of alveolar cell tumor was it possible at bronchoscopy to obtain a specimen of tissue that on microscopic examination showed the tumor The presence of a copious frothy mucoid secretion coming

from an involved segment of the bronchial tree should cause the endoscopist to suspect the possibility of alveolar cell tumor and to collect secretion for cytologic study.

Cytologic examination of the sputum and bronchial secretions is an extremely valuable aid in the diagnosis of alveolar cell tumor. In our experience, a positive diagnosis can be established by this means in two out of three cases.

Treatment.—Surgical intervention is the method of treatment generally employed but so far the results have been far from satisfactory.

BRONCHIAL ADENOMA

Bronchial adenoma is a tumor of a low degree of malignancy that arises from the mucous glands in the wall of the bronchus. Grossly these tumors vary greatly in size and appearance. They generally project into the lumen of the bronchus and are attached to the wall of the bronchus by a pedicle (Fig. 28a). The pedicle may be long and narrow permitting free movement of the tumor in the bronchus, or it may be short and the base of attachment broad (Fig. 28b). Occasionally only a small portion of the adenoma may project into the lumen of the bronchus, the remainder being situated in the bronchial wall and in the adjacent pulmonary tissue.

Adenoma of the bronchus may be divided into two types, namely carcinoid and cylindroma. The carcinoid type is more common, approximately 90 per cent of adenoma being of this variety. Microscopically, carcinoid adenoma can display some flexibility in their histologic pattern. Vascularity of the tumor may be the dominant characteristic in this type, the cells appear at times even to line the blood vessels. At other times, vascularity is much less pronounced. The cells may form solid cords or may be grouped in alveolar clumps, with acinar formation seldom a prominent feature. The histologic pattern of the cylindromatous adenoma also tends to vary somewhat and may be of two types. One assumes a Swiss-cheese pattern in which the irregular roundish and oval spaces are formed by the cells; these spaces are filled with mucoid secretion. The other is the tubercular pattern, in which simple tubercles are formed



Fig 28 Bronchial adenoma. a. Lesion with relatively narrow pedicle (hematoxylin and eosin x4) b. Lesion with broad base of attachment (hematoxylin and eosin x3)

Although it is frequently stated that adenoma of the bronchus occurs primarily in young women, our experience has not borne out this contention we have found approximately the same frequency in men as in women. Although adenoma of the bronchus can occur at any period of life, it tends to appear in younger persons than does carcinoma of the lung

The pulmonary symptoms produced by adenoma of the bronchus depend mainly on the location of the tumor its size and the degree of bronchial obstruction that it produces. An adenoma of small size, especially one located in the

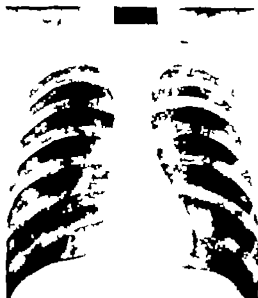


Fig 29 Small adenoma of bronchus causing little generalized roentgenographic change in the lungs

periphery of the lung that does not interfere with drainage of the bronchus or cause obstructive pneumonitis is likely to be asymptomatic (Fig 29) Lesions situated closer to the hilus of the lung and that obstruct a large stem bronchus are much more likely to cause pulmonary symptoms (Fig 30) Cough is the most prevalent symptom, being present in 85 per cent of patients with adenoma Hemoptysis occurs in approximately half the patients Pain, recurrent bouts of chills and fever dyspnea and respiratory wheeze are other symptoms frequently noted

The physical findings, like the symptoms, vary with the size of the tumor its location and the degree of bronchial obstruction Roentgenographic examination of the thorax may afford a definite clue to the identity of the lesion. If



Fig. 30 Adenoma of bronchus, with atelectasis and extensive roentgenographic changes.

the adenoma has reached sufficient size to cast a shadow it tends to produce one of two distinct roentgenologic patterns The more common is that which demonstrates evidence of obstruction of the airway of an entire lung a lobe or a pulmonary segment. The less common form is characterized by a round or oval shadow on the roentgenogram.

Bronchoscopy is of great value in the diagnosis of adenoma of the bronchus As seen through the bronchoscope, the tumor presents a rather characteristic appearance The tumor ordinarily is pedunculated and the mucous membrane that covers it is usually reddish yellow with small vessels coursing over the surface The mucous membrane seldom is ulcerated but pus usually exudes about the growth The tumor as a rule is firm and tends to bleed easily on manipu-

lation. Tissue should be removed from the tumor for microscopic examination in all cases. Cytologic examination of sputum and bronchial secretions is of no value in the diagnosis of this lesion.

Opinion varies as to the most satisfactory treatment of bronchial adenoma. The decision generally rests between removal or destruction of the tumor by bronchoscopic means and surgical extirpation of the tumor by bronchotomy, lobectomy or pneumonectomy. Varying with circumstances, an adenoma that is pedunculated and attached to the bronchial wall by a narrow pedicle and is in such a location that its removal by means of thoracotomy would require pneumonectomy is best excised and removed through the bronchoscope. Adenomas in people of advanced years or with physical ailments that would increase unduly the risk of thoracotomy are also better removed bronchoscopically. All other adenomas are best treated by thoracotomy and complete surgical removal.

BENIGN BRONCHIAL TUMORS

It is unusual for a tumor that is primary in a major bronchus to be anything but a carcinoma or an adenoma

Hamartomas are usually peripheral pulmonary tumors but occasionally they occur in a major bronchus, providing a bronchoscopic problem Approximately 32 such tumors in a major bronchus have been recorded in the literature. It is believed that tumors formerly classified as chondromas, osteochondromas or lipochondromas probably would be classified as hamartomas by present criteria

Lipomas, lipofibromas, fibrolipomas and fibromas are closely related histologically and perhaps should be placed into one of only two groups, namely lipoma or fibroma, depending on the predominant tissue Lipomas occasionally extend through the bronchial wall and present both intra bronchial and extrabronchial portions in a dumbbell fashion

Tumor-forming amyloid is found even less commonly than are the tumors already mentioned It is a localized collection of amorphous material giving the staining characteristics of amyloid It is not associated with generalized amyloidosis.

The symptoms presented by patients having these tumors are those of other bronchial tumors. Cough hemoptysis, wheezing and pneumonitis must lead one to suspect the presence of bronchial obstruction

These tumors occasionally can be successfully removed bronchoscopically but more frequently they require surgical extirpation. When the tumor occurs in a major bronchus, the surgeon should attempt transbronchial removal rather than pulmonary excision unless the portion of lung distal to the tumor is sufficiently diseased to warrant removal

BRONCHOLITHIASIS

Broncholithiasis has been recognized for many years. Up to the time of the American Revolution, approximately 100 authors had described calculi or tophi that had been coughed up or found in the lung. In spite of the long period of its recognition, it remains one of the most overlooked lesions of the bronchial tree.

Broncholithiasis may develop in the tracheobronchial tree from a number of sources. It may originate (1) in the lumen of the bronchus, as seen in the case of a long retained aspirated foreign body (2) in the bronchial wall due to calcification of the bronchial cartilage, or (3) around the bronchus, with subsequent erosion through the wall of the bronchus. Of these three sources, the most frequent is perforation of calcified tuberculous or anthracotic hilar lymph nodes into the tracheobronchial tree.

Pollak, according to Kahler in 1906, was probably the first to observe perforation of a tuberculous lymph node into the trachea. Although the studies of Schwartz[12] indicate that such tuberculous lymph nodes frequently erode into the bronchus, the erosion of calcified lymph nodes is much less common. Sternberg[9] in a review of 6132 cases of pulmonary tuberculosis in which necropsy was performed noted 32 instances in which there was evidence of perforation into the tracheobronchial tree owing to anthracotic nodes.

Broncholithiasis may occur at any period of life but as might be anticipated it is more likely to occur late in life than early. In our experience at the Mayo Clinic more than 70 per cent of the patients were more than 40 years of age. Broncholithiasis is encountered with equal frequency

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in men and women Broncholiths may occur in any part of the trachea or bronchial tree but, as might be expected because of the greater number of lymph nodes occurring adjacent to the right bronchial tree than to the left, a higher percentage of broncholiths will be found on the right side. After the broncholith is extruded into the bronchial tree, it may be coughed from one side to the other

The syndrome of broncholithiasis is that of pulmonary suppurative disease. The severity of symptoms depends on the size and location of the broncholith. Perforation of the bronchus or trachea by a broncholith is usually accompanied by premonitory symptoms of cough wheeze and dyspnea. The patient occasionally may expectorate a small calculus with no more than a mild cough. More frequently the cough is severe and protracted. With the perforation, hemoptysis may occur and a paroxysm of coughing frequently obtains. If the perforating node is large, it may produce alarming dyspnea that may terminate in asphyxia if the node is not removed promptly Broncholiths vary considerably in size Usually they are grayish white and irregular They may show black zones of anthracosis. As a rule, the perforating node is not large and after the initial paroxysm of coughing remains asymptomatic until secondary suppurative changes develop Pieces may break off from the calcified broncholith and in turn cause other calcified deposits, which may reach large numbers.

The possibility of a broncholith should be considered in any case in which the patient gives a history of pulmonary suppurative disease especially if roentgenographic examination of the thorax reveals an abundance of calcareous material at the hilus (Fig 31)

The bronchoscopic appearance in broncholithiasis varies with the stage of development of the broncholiths. If examination is performed before perforation of the node has occurred, one may see nothing abnormal or may notice an inward bulging of the tracheal or bronchial wall into the



Fig. 31 Broncholith in left main bronchus Inset shows the calcified material after bronchoscopic removal

lumen correspond ng to the underlying nod Less frequently one may have the good fortune to see a nod just as t is about to perforate into the tra heobronchial lumen and to remove it More frequently one may find the hole in a bronchus or trachea through which the node perforated and be able to pick out alcified material from the depths of the cavity One or more broncholiths may be found loose in the tracheobronchial tree or embedded in a mass of granulation tissue

The type of treatment depend on whether or not th broncholiths are loose in the tracheobronch l tree and whether or not they are causing symptoms If the bronchol th can be removed by endoscopic means th is the easiest and most satisfactory method of treatment If t cannot be removed by endoscopy and is causing pulmonary symptoms lobectomy or even pneumonectomy may be required

BRONCHOSTENOSIS

Bronchial obstruction may be due to a great many causes. It may be complete or incomplete, constant or intermittent. For an understanding of the mechanics of bronchial obstruction it must be appreciated that the bronchial tree is not a system of rigid tubes. As mentioned previously, the lumen of each bronchus widens and lengthens with inspiration, and it narrows and shortens with expiration; this rhythmic change in bronchial diameter allows certain lesions to obstruct the bronchus more nearly completely during expiration than during inspiration.

In the present discussion, bronchial obstruction due to a foreign body, benign or malignant tumors, or tuberculosis will not be considered. Ephraim,[8] Mann,[1] von Schrotter[8] and others called attention to the fact that swelling of the mucous membrane may take place in chronic bronchitis, which in turn may lead to obstruction of a bronchus of small caliber. Such obstruction is most likely to occur in a secondary or tertiary bronchus. Bronchostenosis characteristically causes repeated attacks of chills, fever, cough and the sputum-retention syndrome, in which symptoms clear rapidly when the patient succeeds in expectorating the infected retained secretion. Obstruction of the bronchus due to swelling of this type usually lasts 3 to 5 days. Patients may become so accustomed to their symptoms that they are unaware of them and pay no heed to the underlying cause.

The episodes of chills and fever may occur at various intervals and often may be mistaken for attacks of pneumonia, malaria or rheumatic fever. Physical and roentgenographic examinations between such attacks may reveal no abnormal

ities, but during an episode of fever and cough they may give evidence of consolidation of the segment or lobe distal to the obstruction If the narrowed bronchus can be found and the bronchus adequately dilated, the patient s symptoms will promptly subside However the dilation may ha e to be repeated at various intervals, as stenosis may recur

ATELECTASIS

Atelectasis is a complicated phenomenon, and considerable controversy over definition of the term has taken place. Although, according to Gairdner,[4] Louis first distinguished pneumonia from atelectasis in 1829, it was not until 1890, with Pasteur's[14] description of massive atelectasis, that the attention of the medical profession was attracted to this condition. Many theories have been advanced to account for the development of atelectasis.

For clinical purposes, Adamson has offered a useful classification of the types of atelectasis as follows: (1) congenital atelectasis with bronchial atresia, or agenesis of alveoli with interference in aeration of small or large portions of the lung; (2) adjustment atelectasis, which represents a decrease in the volume of the lung occasioned by pleural effusion, paralysis of respiratory muscles, and other factors that decrease the effective intrathoracic space; (3) obstructive atelectasis, which results from bronchial occlusion.

The third type is of chief practical importance. It is classified into two subgroups, namely that occurring after an operative procedure and that due to other causes. It is said to occur in 10 per cent of operations performed on the thorax or upper part of the abdomen.

The sequence of events in postoperative atelectasis and in massive atelectasis of nonsurgical origin is as follows. As a result of shock, suppressed cough reflex and dehydration, thick tenacious secretion is formed and may plug the bronchial tree. As a rule, most patients who aspirate material into the lung while under anesthesia are able to rid themselves of this material on recovering consciousness, through either the

cough reflex or ciliary action If the material is not expelled however and is permitted to remain in the bronchus it soon leads to atelectasis of the portion of lung beyond the point of bronchial obstruction

The syndrome associated with atelectasis follows a rather definite pattern. The patient usually complains of dyspnea that is frequently out of proportion to the degree of pulmonary involvement, and also of a sense of discomfort over the thorax corresponding to the involved lung The pulse accelerates and the temperature suddenly increases Cyanosis is often present, its degree depending on the amount of tissue involved In massive atelectasis, the heart and mediastinal structures shift toward the side of involvement, and the respiratory excursion on the affected side decreases Postoperative atelectasis itself is not primarily a suppurative process, but secondary infection may develop readily if it is permitted to persist.

Bronchoscopy is of the greatest value not only in the treatment of all types of atelectasis but also in the prevention of postoperative atelectasis, for this condition can be largely prevented by eliminating the factors that give rise to its development No patient should be permitted to leave the operating table with a so-called wet lung Most patients who have postoperative atelectasis are able to overcome the difficulty simply by rolling over on the uninvolved side and coughing up the retained secretion In certain cases, however this procedure does not suffice and more drastic measures must be employed A catheter may be introduced into the trachea to stimulate cough If this is ineffective bronchoscopy can be of great value In the early stages, a tenacious plug usually can be seen at the time of bronchoscopy and can be aspirated, with prompt subsidence of the zone of atelectasis (Fig 32) If atelectasis has persisted for an appreciable period, the plug of mucus may have undergone resolution and the bronchus will be filled with mucopurulent or even serous material As much as 300 to 500 ml of this material





Fig 32. Massive atelectasis b. Th day after bronchoscopic aspiration

often can be aspirated from the bronchus with pronounced improvement in the patient's condition

BRONCHIAL OBSTRUCTION BY COMPRESSION

Compression of the trachea or bronchi may be produced by structures in apposition to the airway. It is almost impossible to distinguish the clinical symptoms and signs produced by such obstruction from those caused by intrabronchial and intratracheal obstruction.

The trachea is susceptible to compression by such lesions as vascular anomalies, intrathoracic thyroidal adenomas, mediastinal tumors and cysts, bronchial cysts and metastatic deposits in lymph nodes. The bronchi also can be compressed by similar lesions, along with such entities as thymic tumors or lymphosarcoma. Enlarged peribronchial lymph nodes may cause bronchial compression (Fig 33). Although such obstruction may be encountered in any pulmonary lobe, the bronchus of the middle lobe on the right is especially prone to such occlusion by enlarged lymph nodes. As a result of such obstruction, the lobe decreases in size and becomes consolidated, with dilatation of the bronchi; there may be evidence of suppuration, depending on the duration of obstruction. This change when present in the middle lobe is often described as the "middle lobe syndrome" (Fig 34). Obstructive pneumonitis with bronchiectasis may occur in any part of the lung.

Roentgenologic examination of the thorax, especially tomography, may reveal the exact location of an obstruction of the bronchus. Bronchography also may be of value in this respect. Unfortunately it does not indicate the exact nature of the causative lesion. Although bronchoscopy may demonstrate the site of obstruction and on occasion furnish

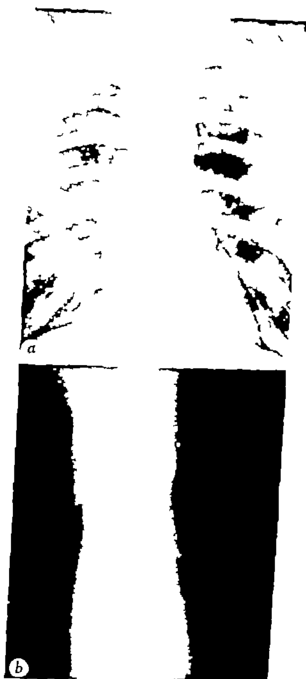


Fig. 33 Compression of lower end of trachea by a calcified lymph node. Anteroposterior view. b Tomogram.



Fig. 34. Bronchographic appearance in middle-lobe syndrome caused by bronchiolitis. a Anteroposterior view. b Lateral view

a clue as to its possible cause, this is the exception rather than the rule

When indicated surgical resection of the segment of the lung affected by the obstruction is usually curative. On occasion at operation and on pathologic study an obstructing lesion cannot be identified because it either has eroded into the bronchus or has undergone retrogression, leaving only the residue of the damage produced When compression is caused by enlargement of the thyroid gland or a thymoma, the tumor may be successfully resected The collapse of the trachea that occurs after removal of an adenomatous goiter that has compressed the trachea may be obviated at times by insertion of a bronchoscope or tracheotomy tube into the trachea. Collapse of the trachea following thyroidectomy may be permanent. Carcinoma of the thyroid occasionally perforates into the trachea and causes respiratory symptoms it may be possible in such cases to obtain tissue from the trachea at the time of bronchoscopic examination and establish the correct diagnosis.

BRONCHO-ESOPHAGEAL AND TRACHEO-ESOPHAGEAL FISTULAS

Tracheo-esophageal and broncho-esophageal fistulae are comparatively rare conditions that may be congenital or acquired in origin. Congenital fistulas generally are associated with esophageal atresia. If allowed to persist, they rapidly give rise to pulmonary suppuration and death. Much progress has been made in recent years in their early diagnosis, and definite advancements have been made in their successful surgical closure. One variety of congenital broncho-esophageal fistula exists that is not associated with esophageal atresia and is compatible with life. In this type the opening between the esophagus and bronchus is of such a size and position that solid foods, especially, do not readily gain access to the bronchus (Fig. 35). While liquids can and do pass through the fistula, the patient soon learns to restrict the intake of fluid and learns that it is possible by drinking in certain positions to restrict the amount of fluid that enters the bronchus. It is surprising how the bronchial tree in such cases accommodates itself to the irritation from the offending liquids and solids.

Acquired tracheo-esophageal and broncho-esophageal fistulas may be due to a great variety of conditions. Carcinoma of the esophagus, usually terminal in nature, is the commonest cause of such lesions. Foreign bodies in the esophagus may cause a fistula between the esophagus and the tracheobronchial tree. The removal of such a foreign body often is followed by spontaneous closure of the fistulous tract. Fistulas resulting from trauma are usually amenable to surgical intervention. Syphilitic fistulas are best treated by



Fig 35 Broncho-esophageal fistula

measures directed toward the syphilitic infection and often will close without further treatment. Fistulas secondary to traction diverticula usually do not appear until after the second decade of life, for traction diverticula of the esophagus do not manifest themselves until after this age In a fistula associated with traction diverticula a calcified node or nodes invariably will be found along the course of the fistulous tract and must be removed at the time of operation if the fistula is to be closed successfully Fungous disease, such as actinomycosis, may produce broncho-esophageal fistulas. The local application of caustics to the fistulous tract seldom brings about closure

The differential diagnosis between tracheo-esophageal fistula and bulbar palsy at times may offer considerable difficulty. Esophagoscopy, bronchoscopy and studies of esophageal motility, along with roentgenographic examination and the instillation of opaque media, may be necessary to allow a correct diagnosis.

ASTHMA

The present discussion will not encompass the entire problem of bronchial asthma but will be limited to the role of bronchoscopy in dealing with the situation. Bronchoscopy has been recognized for a long time as of value in the treatment of asthma. Pieniazek,[19] in 1905 was probably the first to carry out an endoscopic examination on a patient during the course of an asthmatic attack. He found that the bronchi were greatly congested with considerable stenosis of the smaller bronchi during the period of attack. These findings subsequently have been confirmed frequently by other observers. The bronchi often are filled with a tenacious gelatinous secretion. In the intervals between attacks of asthma the bronchial mucous membrane may appear perfectly normal. In many cases, however residual evidence of bronchitis will be found

Since Pieniazek s report, many writers have pointed out that good results may be obtained in the treatment of asthma by bronchoscopic aspiration. The simple process of aspirating secretion from the bronchus may result in improvement in the condition, but as a rule improvement is only temporary

An important complication of either allergic or infectious asthma is bronchostenosis. This bronchostenosis is inflammatory in origin and is not referable to allergic edema or bronchial asthma Two outstanding disturbances of function result when a bronchus becomes stenosed namely (1) movement of air entering or leaving the pulmonary tissues beyond the region of stenosis is inhibited, and (2) bronchial secretions, which usually are excessive in asthma are retained below the stenotic zone so that a region of partial or complete

atelectasis results. The possibility of bronchostenosis should be entertained in any asthmatic patient who has had attacks in which the cough becomes nonproductive and is associated with febrile episodes either with or without preceding chills. As a rule the fever lasts 2 to 5 days. With subsidence of fever the amount of sputum usually increases It should be emphasized that febrile episodes, hemoptysis or purulent sputum does not accompany uncomplicated asthma

Bronchoscopic examination may disclose one or more stenotic bronchi. The superior branches of the bronchi to the lower lobes are involved most frequently The stenotic bronchus is dilated carefully after which a small amount of purulent secretion usually can be aspirated When bronchostenosis is present and the stenotic bronchus is dilated adequately the patient usually experiences prompt improvement of the asthma Recurrence of bronchostenosis may take place in such instances, further bronchoscopic dilation of the stenotic zone is indicated

SYPHILIS OF THE TRACHEOBRONCHIAL TREE

Syphilis of the tracheobronchial tree is extremely rare at present. It tends to assume one of two types, namely (1) lesions of gummatous infiltrative nature, and (2) lesions that are produced by secondary cicatricial stricture. No characteristic symptoms are ascribable to the disease. A diagnosis of syphilis based only on positive results of serologic tests does not always signify that a lesion involving the tracheobronchial tree is of syphilitic origin. While microscopic examination of tissue removed from the lesion may be suggestive of syphilis, the final diagnosis often depends on the response of the lesion to antisyphilitic therapy.

HEMOPTYSIS

Bronchoscopy is indicated in any case of unexplained hemoptysis. Such a statement assumes that tuberculosis, pneumonia, aneurysm or cardiac decompensation has been excluded as an etiologic factor. Some difference of opinion exists as to how soon after pulmonary hemorrhage bronchoscopy should be performed. Myerson recommended that at least 10 days should elapse between the hemorrhage and bronchoscopy. We agree with Arbuckle that it is safe and the best results are obtained, if the examination is done as soon as possible after the bleeding has subsided. It is thus possible by tracing the blood in the bronchial tree to determine more easily from which bronchus the bleeding is arising and also the cause of the hemorrhage. When results of bronchoscopic examination are negative, bilateral bronchography should be performed.

Among the more common causes of hemoptysis are tuberculosis, carcinoma, mitral stenosis, benign tumor, bronchiectasis, pulmonary abscess, broncholithiasis, foreign body, acute tracheobronchitis such as follows inhalation of various irritating gases, and diffuse polypoid laryngotracheobronchitis. The opinion most frequently reached in cases in which the source of gross hemorrhage is not readily apparent is that the bleeding must be due to varices. It has been our experience that such varices are rare and that the bleeding usually comes from some other source. Gerlings[7] reported three cases of hemoptysis due to venous stasis of the trachea in which treatment by cautery was used. A great difference exists in the tendency of mucous membranes to bleed. It is not possible in some cases to determine definitely the

cause of bleeding which appears to be diapedesis. This condition often is associated with hypertension.

Various methods of treatment have been advocated for pulmonary bleeding of indeterminate origin, among which may be mentioned the use of venom from the moccasin snake. Beneficial results sometimes may be obtained, according to Vinson,[44] in cases of unexplained pulmonary hemorrhage, such as in diffuse tracheobronchitis, by curettage of the involved bronchus followed by insufflation of powdered sulfanilamide. When the bleeding is attributable to other causes, the hemorrhage may be controlled at times by local application of cocaine and epinephrine, as well as by local pressure with a tampon at the site of bleeding. The local application of a small amount of fer-de-lance venom to the site of bleeding will adequately control the hemorrhage.

TRAUMA

Rupture of the trachea and bronchi may result from severe blows or crushing injuries to the thorax. Such rupture may occur without fractured ribs. Shearing forces cause the tear which is located most commonly within a few cent meters of the bifurcation of the trachea Separate t ars of the trachea and bronchi may occur simultaneously but the injury is located most frequently in one of the major bronchi It appears that rupture of the trachea alone is less common than is rupture of the bronchi

Clinical findings result from th escape of blood and air Hemoptysis and hemothorax may be present Mediastinal or subcutaneous emphysema or pneumothorax is noted Leakage of large amounts of air is common and frequently persists even after the application of supposedly adequate measures, such as constant ntrapleural suction The sit of bronchial rupture may become sealed, preventing loss of air but the lung then may fail to re-expand and lead one to suspect the correct diagnosis Dyspnea, cyanosis and shock are common

Bronchoscopy should be done to verify the diagnosis when the presence of rupture is suspected Inasmuch a the tea is usually in a major bronchus, bronchoscopic visualization of the defect should not be difficult.

Treatment should consist of prompt emergency measures if the patient is to survive. Adequate intrapleural suction oxygen, general measures to combat shock and attention to associated injuries are essential In 1947 Kinsella and Johnsrud reported that only 19 of 40 patients w th rupture of a bronchu had survived Those who lived had bronchial

TABLE

CLASSIFICATION OF 82 PRIMARY NEOPLASMS OF THE TRACHEA

Malignant	
Squamous cell carcinoma	19
Cylindroma (adenoma)	18
Hemangio-endothelioma	3
Myxofibrochondro-osteogenic sarcoma	1
Adenocarcinoma	6
	47
Benign	
Papilloma	22
Tracheopathia osteoplastica	8
Amyloid tumor	2
Xanthoma	2
Chondroma	1
	35

strictures, with collapsed lungs. Patients treated prior to 1947 seldom had surgical intervention at present, primary bronchial repair through a thoracotomy is to be recommended as soon as the general condition will permit One need not be concerned about the blood supply to the distal segment of the ruptured bronchus, because sufficient collaterals exist to assure an adequate source of blood

Late restoration of the bronchial lumen has been accomplished both experimentally and clinically Excision of the stricture, with end to-end anastomosis, has resulted in re expansion and restoration of the function of the collapsed lung even several years after the bronchus was injured

The late treatment of tracheal stricture still presents a problem Conservative treatment consisting of placement of a rigid tube for 3 months or more, may be tried When the stricture is in the lower part of the trachea, this may be done by use of a tracheotomy tube. If the stricture is in the upper portion of the trachea tracheotomy should be per formed first and then a rigid tube may be inserted Removal of the tube before 3 months have elapsed frequently results in recurrence of the stricture If this treatment is unsuccessful in retaining sufficient lumen and if the excision of the

stricture would require removal of no more than three or four tracheal cartilages, it is reasonable to consider excision and primary anastomosis

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